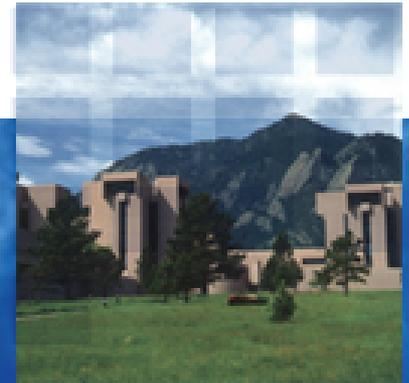
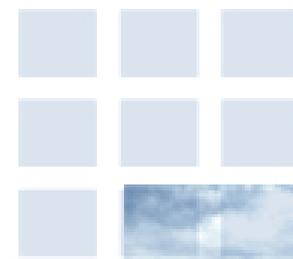




NCAR

16 April, 2009



NCAR: Supporting Aviation Weather

Bruce Carmichael

Director, Aviation Applications Program

National Center for Atmospheric Research

Advanced Weather Products for the Next Generation Air Transportation System

- **Provide the necessary scientific underpinning and technology to support the weather- and climate-related needs of NextGen including:**
 - collaboratively determine the role of weather in aviation operations with operational stakeholders,
 - tailor solutions to operational user's needs via integrated (weather and operational parameters) decision information to address safety, capacity and efficiency issues,
 - collaboratively (with other NextGen partners) build and test the weather component of NextGen referred to as NextGen Network Enabled Weather (NNEW), and
 - collaboratively build and test fully integrated components of NextGen.

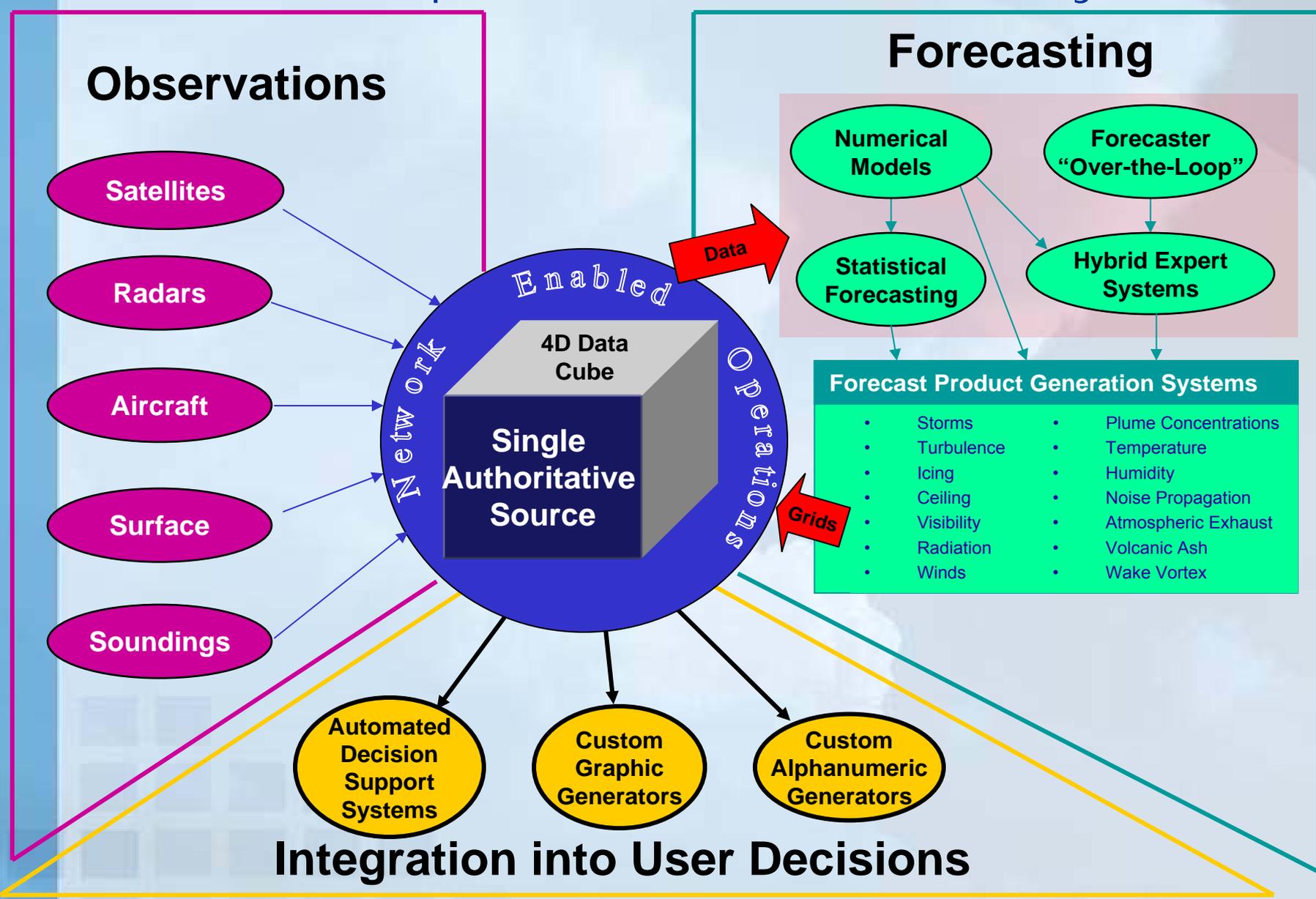
RTCA Task Force on NextGen Mid-Term Implementation

- **Federal Advisory Committee**
- **Catalyst for government-industry collaboration to transform the NextGen Integrated Work Plan into reality**
- **NextGen Task Force will:**
 - Forge a consensus-based set of recommendations
 - Prioritize a set of operational capabilities
 - Develop a positive business case
 - Target capability delivery by 2018
 - Recommend when, where, and how the FAA and operators should implement the needed infrastructure, aircraft equipage, policies, procedures, training

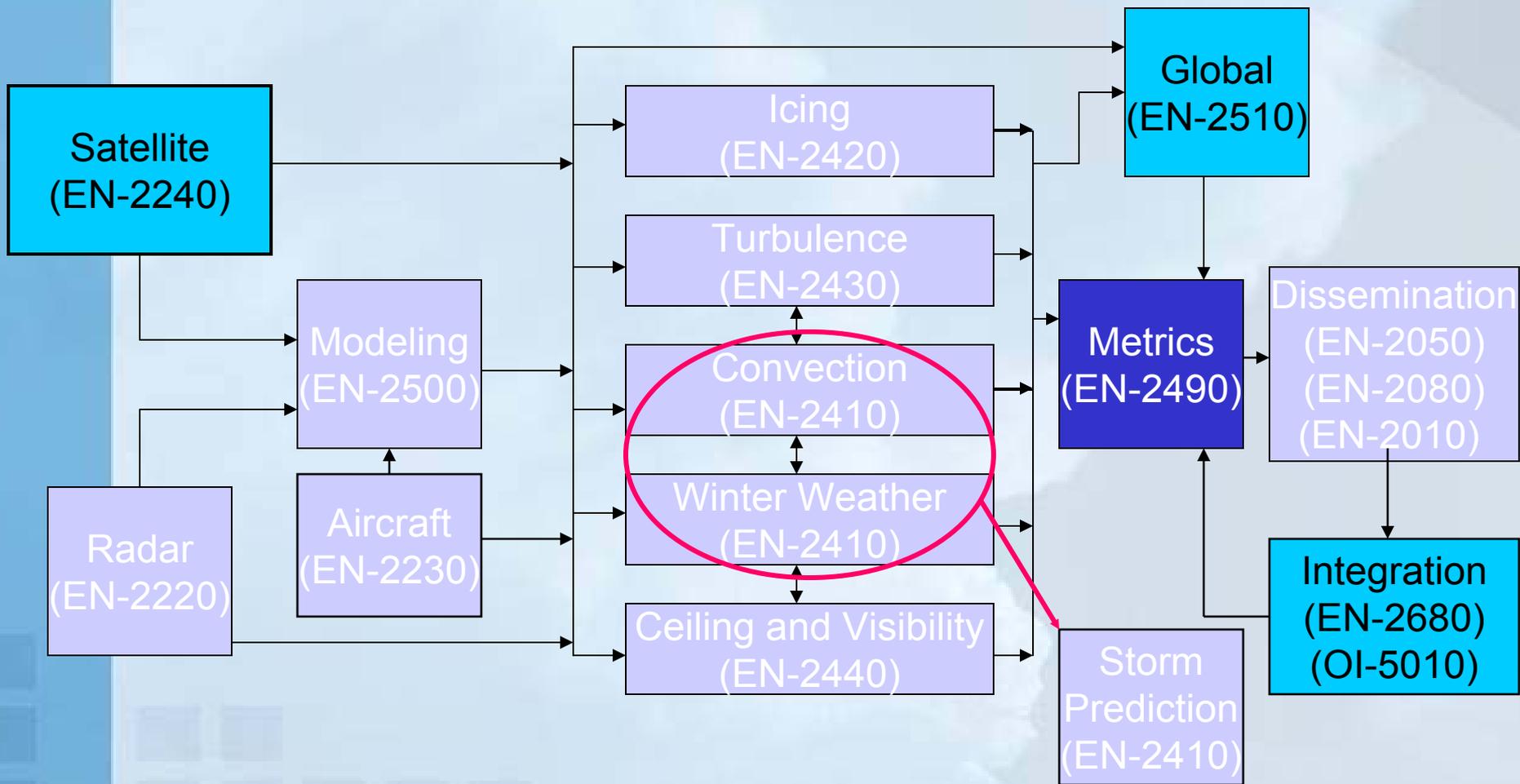
Weather/ATM Integration Plan

- **Survey of current research areas**
- **Identification of missing research elements**
- **Setting priorities of weather and ATM research tasking**
- **Development of a roadmap**
- **Coordination with stakeholders**

NextGen Network Enabled Weather: A Core Concept for the Future of Our System



Overview of NCAR Aviation Research Activities with Links to NextGen Enablers



Frontiers: Probabilistic Forecasting, Volcanic Ash, Space Weather, Environmental Forecasts (Noise, Emissions, Climate)

Right Sizing of Observing Network

Goal:

- Assessment of observing network adequacy for IOC in 2013
- Identification of gaps & opportunities
- Development of master plan for advancing observing capabilities to satisfy NextGen needs in 2025
- NCAR is Subteam Lead for surface, airborne, and satellite observations

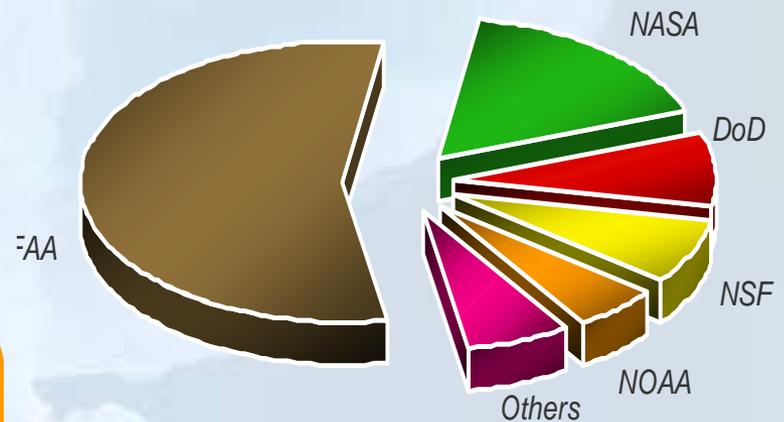
Convective Weather Program

Goals:

- Advancement of short-term (0-8 h) prediction of high-impact weather
- Close interaction with users & integration with specific applications

Projects:

- CoSPA
- DFW Forecaster over Loop & AWIPS
- Probabilistic Weather & ATM
- Oceanic Weather & Global Turbulence
- Satellite Convective Initiation
- STEP Nowcasting (2x)
- Beijing Nowcaster & FDP08
- Korea Multi-Parameter Radar
- Predictive Skills of Satellite Precipitation
- ATEC Nowcasting



New & Expected Projects:

- FAA Right Sizing Network
- Florida Forecaster over Loop
- Taiwan Nowcasting

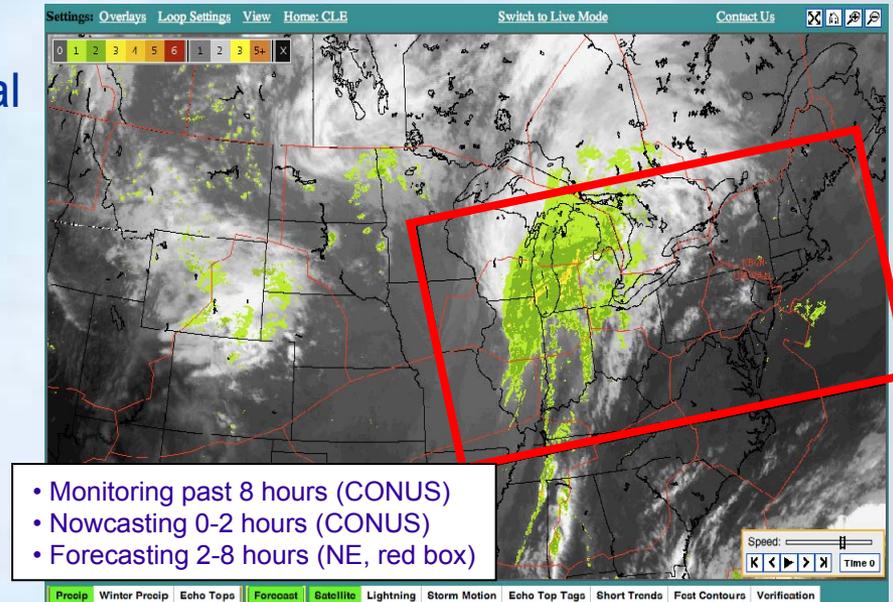
Convective Weather / CoSPA

Goal:

- Consolidation of a plethora of different convective & winter weather forecast products into a single prediction system for aviation that builds upon best available techniques & algorithms
- Collaborative effort between MIT/LL (lead), NCAR/RAL, & NOAA/GSD

Major Focus Areas:

- Blending of extrapolation & numerical model prediction forecasts
- Numerical modeling & data assimilation
- Statistical analyses of predictor field contributions
- Forecast uncertainty (i.e., probabilistic forecasting)
- User interaction



NWS Forecaster over Loop

Goal:

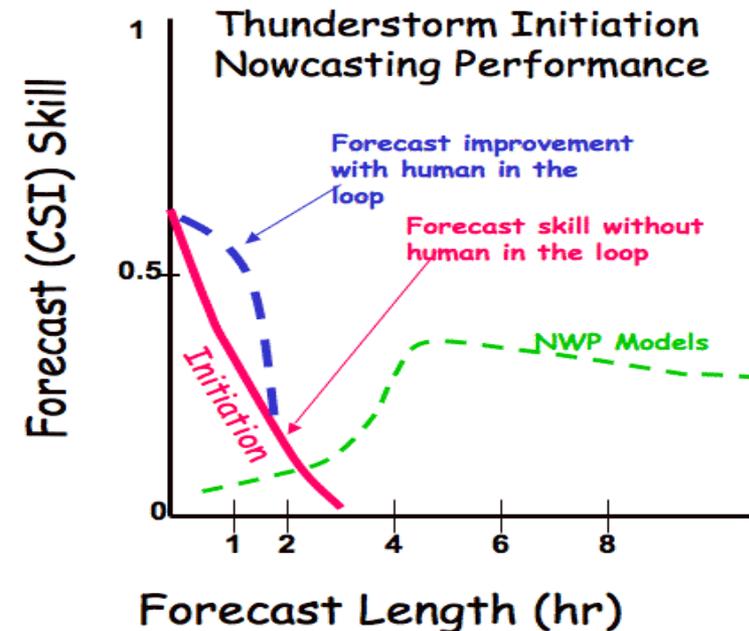
- Assess role of forecaster in adding value to automated & gridded nowcast products
- Improve consistency, reliability & accuracy of 0-2 h forecast products
- Consider role of human for NextGen era



Forecaster using ANC at DFW WFO

FY08 Accomplishments:

- Transferred Autonowcaster to AWIPS
- Extensive analyses of summer 2007 & 08 data
- Forecaster input increases CSI by 0.2-0.3
- Several conference papers & presentations



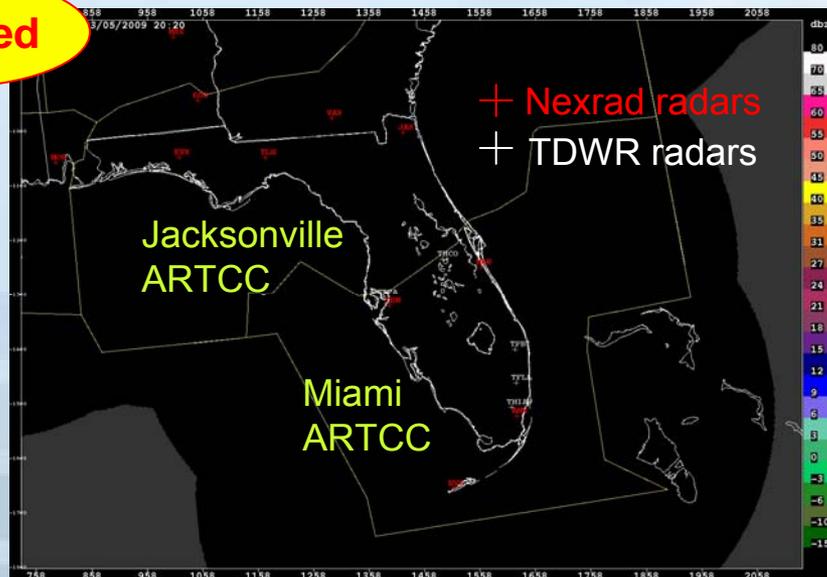
Plans for FY09 & Beyond:

- Continue assessment of forecaster added value
 - forecasters can now enter boundaries & nudge storm initiation fields in AWIPS
 - expansion to multi-WFO domain
- Working on probabilistic forecasts

Planning for participation in NextGen capability demonstration in Florida

- installation & demonstration of AWIPS-ANC at Melbourne, Florida WFO

Expected



Dan Megenhardt from NCAR receives U.S. Department of Commerce Certificate of Recognition

Ground Icing Research

- **Ground Deicing Hazards**
 - Snow/Snow Pellets
 - Freezing Precipitation
 - Ice Pellets
- **Hazards being addressed through development of a liquid water equivalent (LWE) based system to assist in de-icing operations**
- **Ultimate goal is approval of an automated system for determining holdover times (Checktime system)**

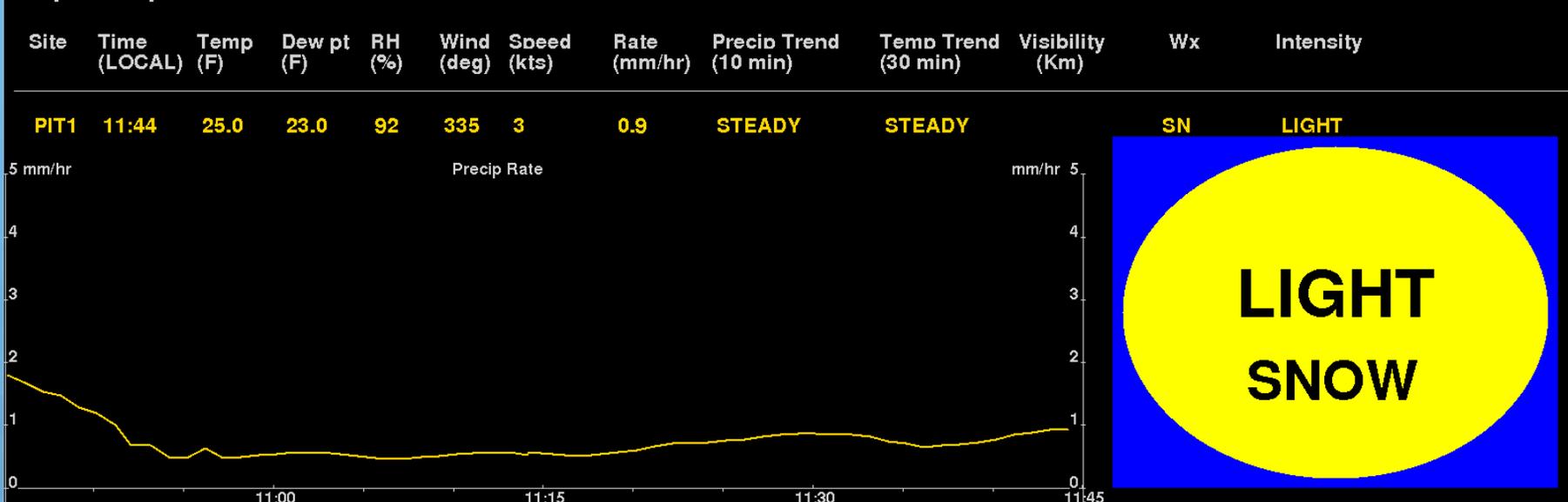


Liquid Water Equivalent (LWE) System

- Currently being used at Denver International, Minneapolis/St Paul, Chicago O'Hare and Pittsburgh airports

Liquid Equivalent Snow and Rain Rates and Intensities

02/14/07 11:45:00 Local



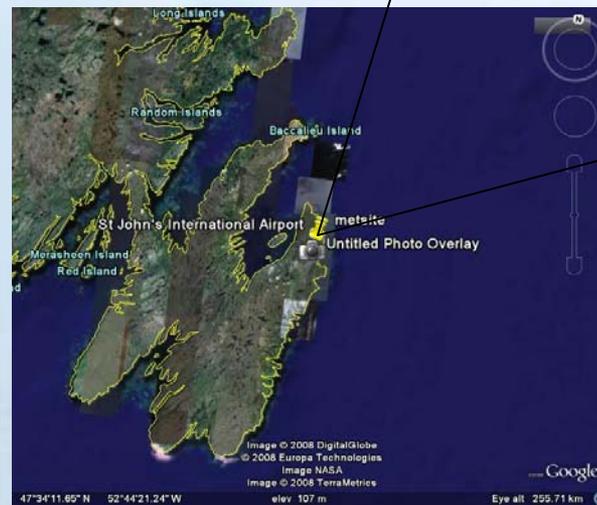
Marshall Test Site

- **Primary location for testing of LWE system**
- **Various precipitation gauges were evaluated and compared against manual pan observations**



LWE System Deployment at St. Johns, New Foundland

- Piggybacking on Canadian project for fog and freezing drizzle
- LWE system deployed from April 1 – 30, 2009



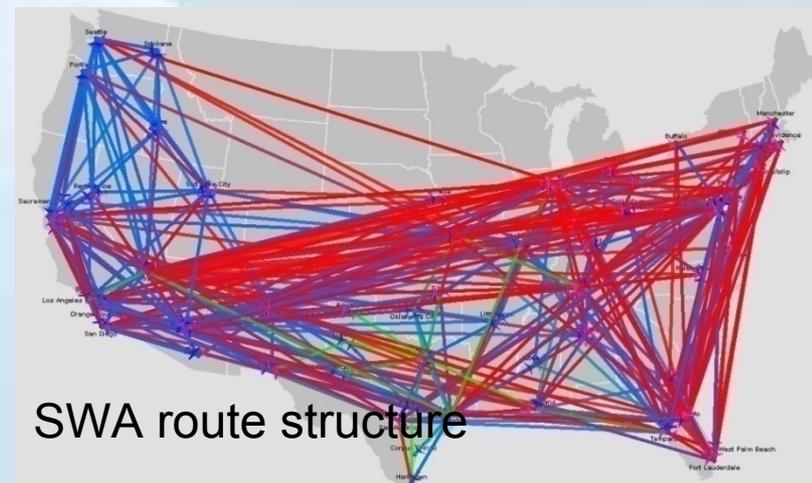
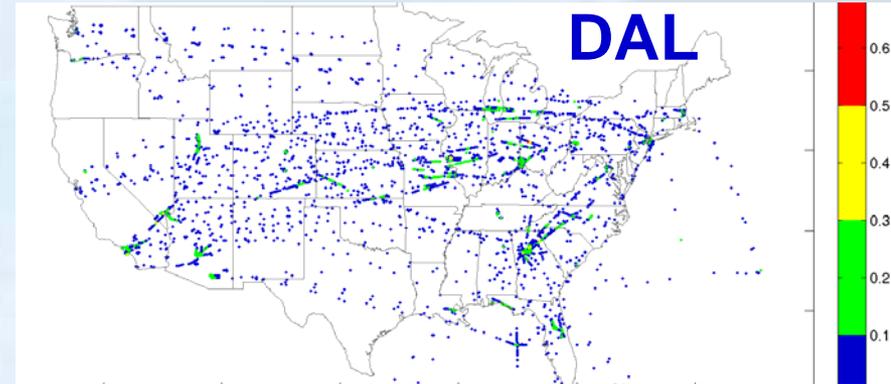
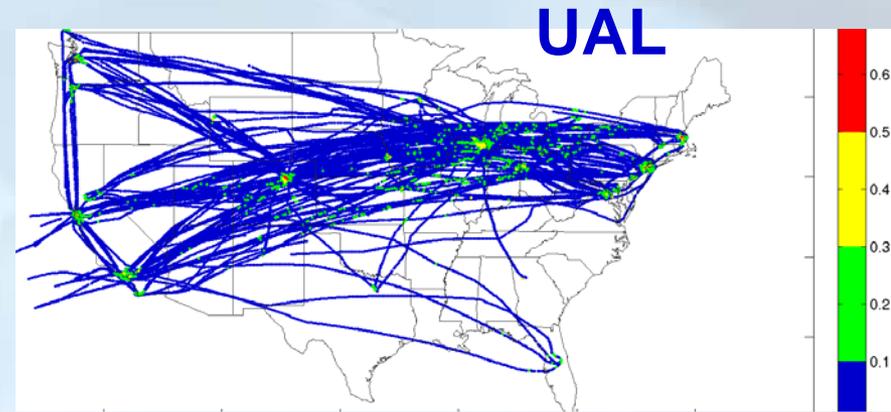
In situ edr measurements

- **Background**

- Provides atmospheric turbulence metric: eddy dissipation rate (EDR)
- Records peak and mean
 - UAL every minute
 - Algorithm updated to event-based recording + heartbeat

- **Status**

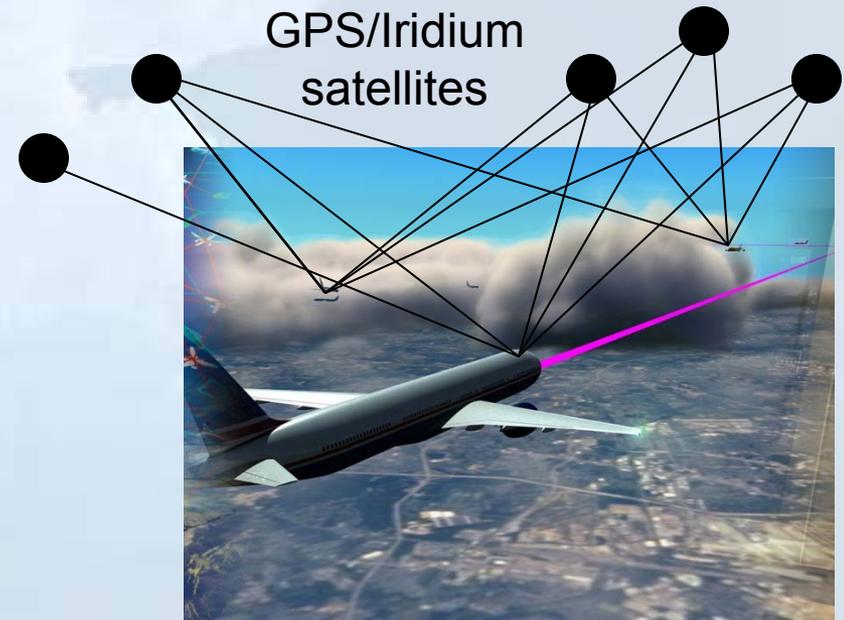
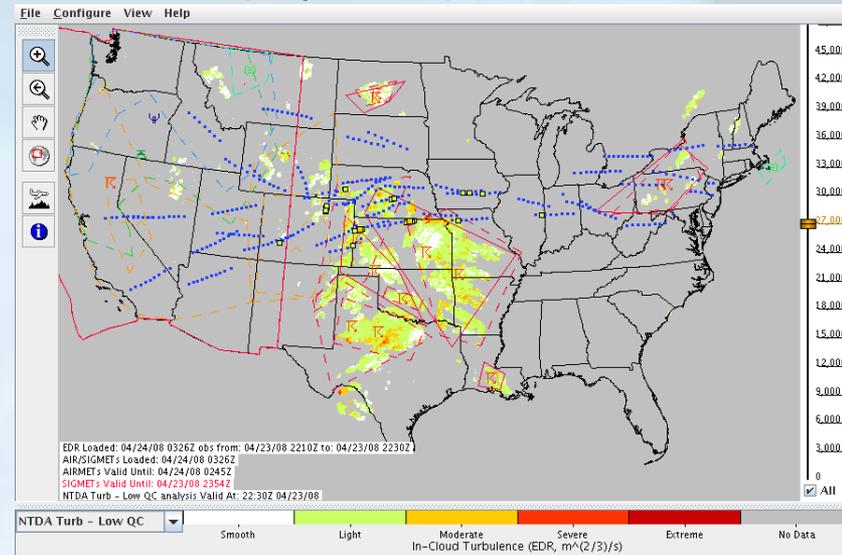
- 100 UAL 737s and 100 UAL 757s (accelerometer based 1 min updates)
- ~ 70 DAL 737-800s (event-driven vertical winds based algorithm)
- 4 SWA aircraft in test evaluations (expect fleet implementation on ~ 280 737-700s in CY09)
- Update UAL 757s to wind-based algorithm



Remote sensing activities

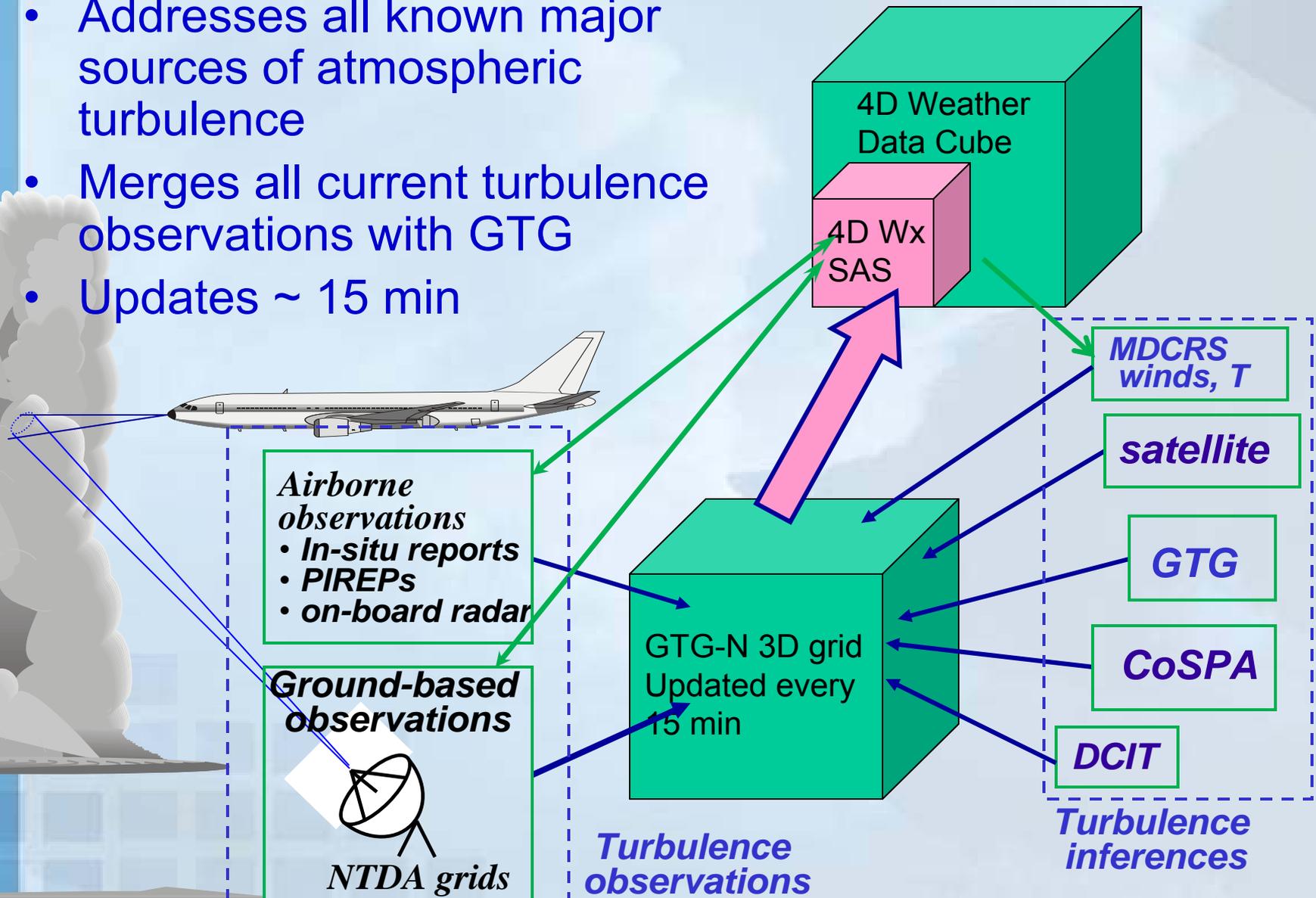
- **NEXRAD in-cloud Turbulence Detection Algorithm (NTDA)**
 - Uses NEXRAD radar data Doppler spectral width \Rightarrow EDR
 - NTDA-1 deployed on all NEXRADs in 2008 as part of ORPG Build 10
 - NTDA-2 Build 12 update (2010)
 - Prototype running in real-time at NCAR on Level II data from 133 NEXRADs
 - Experimental CONUS mosaic of in-cloud EDR produced every 5 min.
- Evaluate feasibility of using GPS scintillation measurements
- Evaluate the feasibility of sensing turbulence with a passive, forward-looking IR interferometer (FLIR)
- Forward-looking low-power lidar that feeds directly into controls system (Boeing)

NTDA display on Experimental ADDS



GTG-N: Turbulence Nowcast System

- Addresses all known major sources of atmospheric turbulence
- Merges all current turbulence observations with GTG
- Updates ~ 15 min



Turbulence Nowcast/Forecast Product: Graphical Turbulence Guidance (GTG)

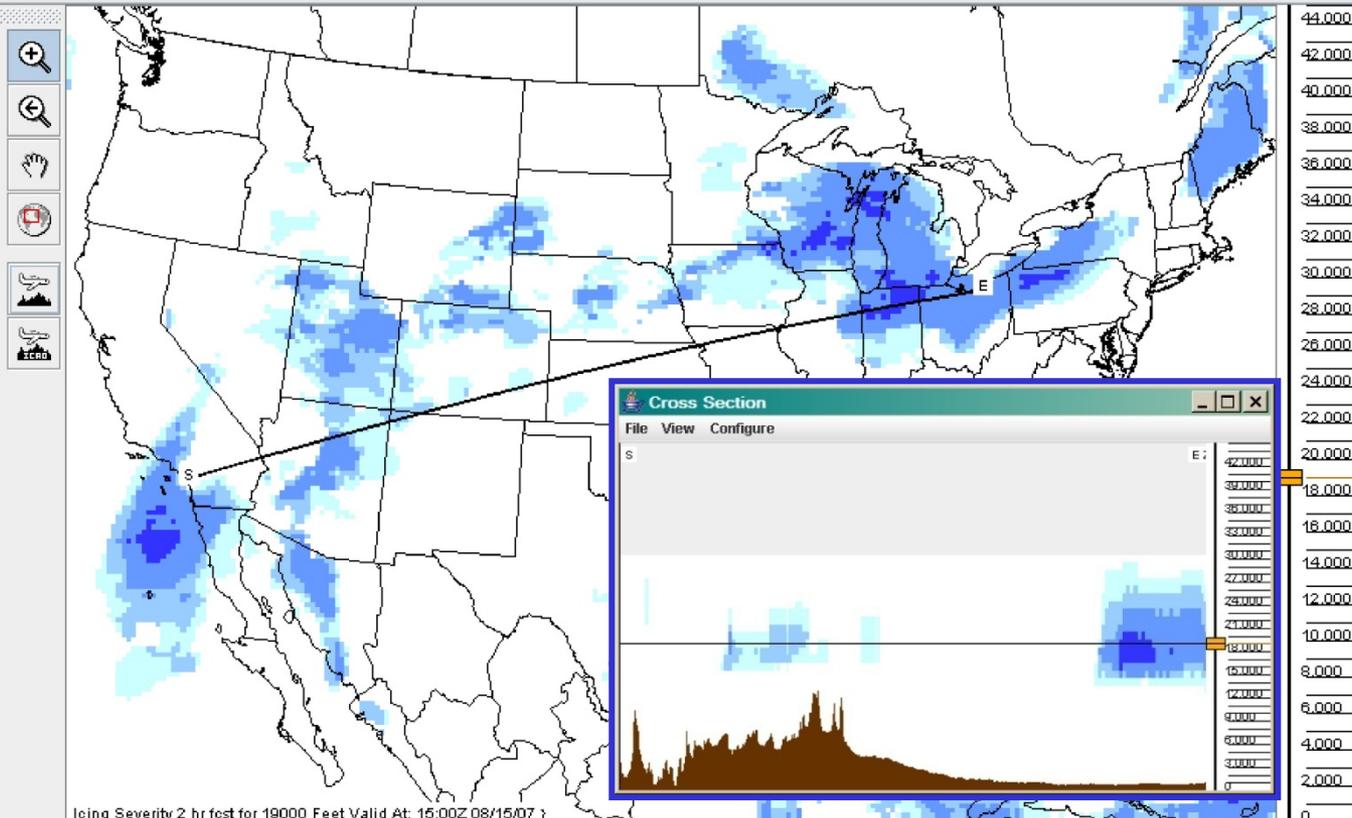
- **Based on RUC, GFS, or WRF NWP forecasts**
- **Current work areas:**
 - Optimal use of *in situ* reports
 - Probability of MOG, SOG > some EDR threshold
 - Improve forecasts of severe turbulence
 - Alternative combination methods
 - Explicit MWT, CIT diagnoses (DCIT) and forecasts
 - Global applications (global GFS, regional WRF)
 - Incorporate satellite-based feature detectors
- **GTG-N**
 - Rapid updates (~15 min)
 - Combines most recent observations, GTG, DCIT
- **Output expected to populate the SAS of the NextGen 4D virtual data cube**

In-Flight Icing Hazard Products Currently Available

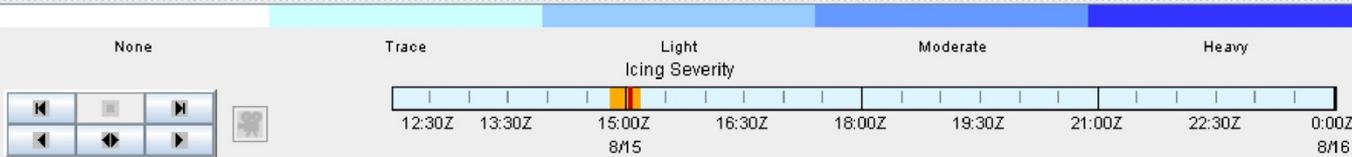
- **CIP/FIP**
 - Gridded, 4-dimensional icing products
 - Icing severity, probability and SLD likelihood
- **CIP: combines observations and model output**
 - Fuzzy logic technique to pull out icing interest fields
 - Weighted and combined
- **FIP: similar to CIP but only weather models are used**
- **Both: 20km x 20km x 1000ft, issued hourly**
- **FIP Forecast lead times 1,3,6,9 h**

Flight Path Tool (Default Configuration)

File View Configure



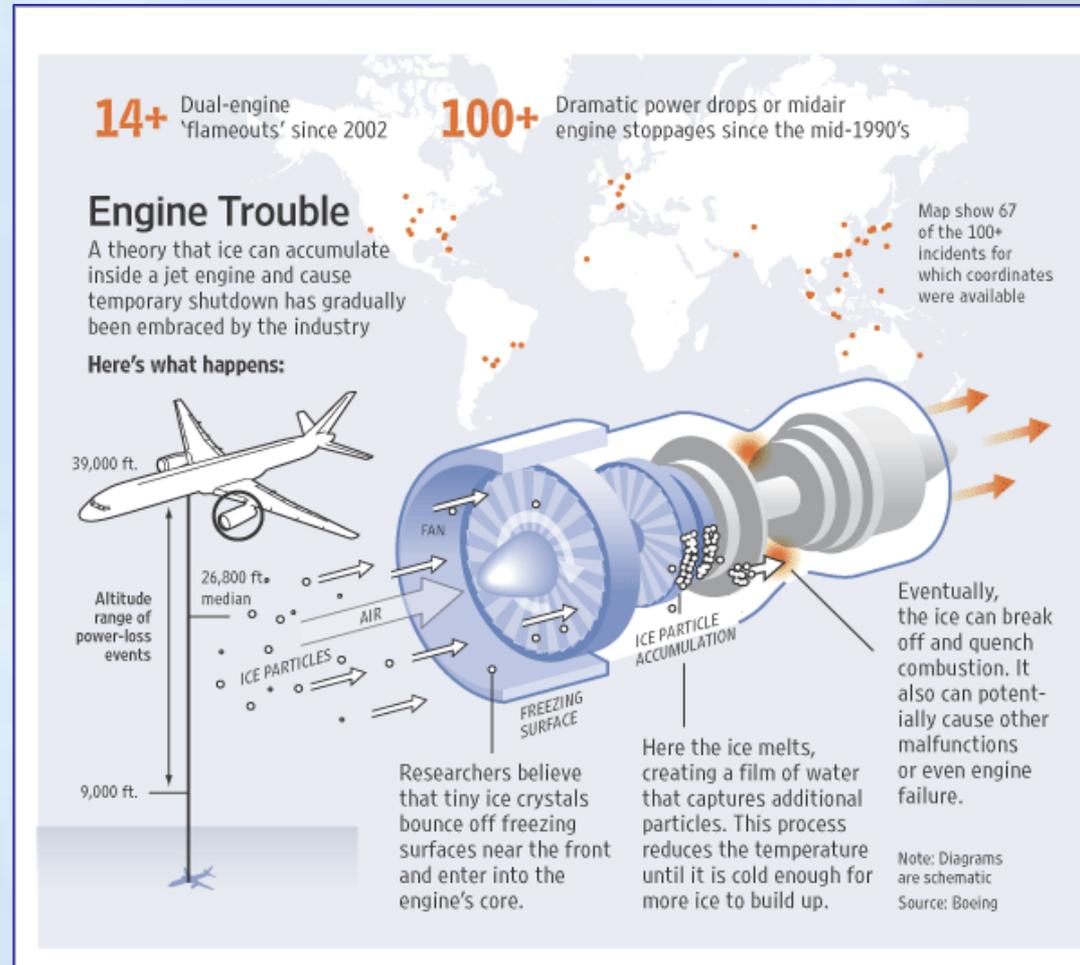
Icing Severity 2 hr frost for 19000 Feet Valid At: 15:00Z 08/15/07



Data Layers	Available Data Sets
<input type="checkbox"/> Wind Barbs	<input type="checkbox"/>
<input type="checkbox"/> METARs	<input type="checkbox"/>
<input type="checkbox"/> PIREPs	<input type="checkbox"/>
<input type="checkbox"/> AIR/SIGMETs	<input type="checkbox"/>

High Ice Water Content Engine Ingest

**Build HIWC
warning tool based
on available
observations
combined with up-
to-date knowledge
of the phenomenon**



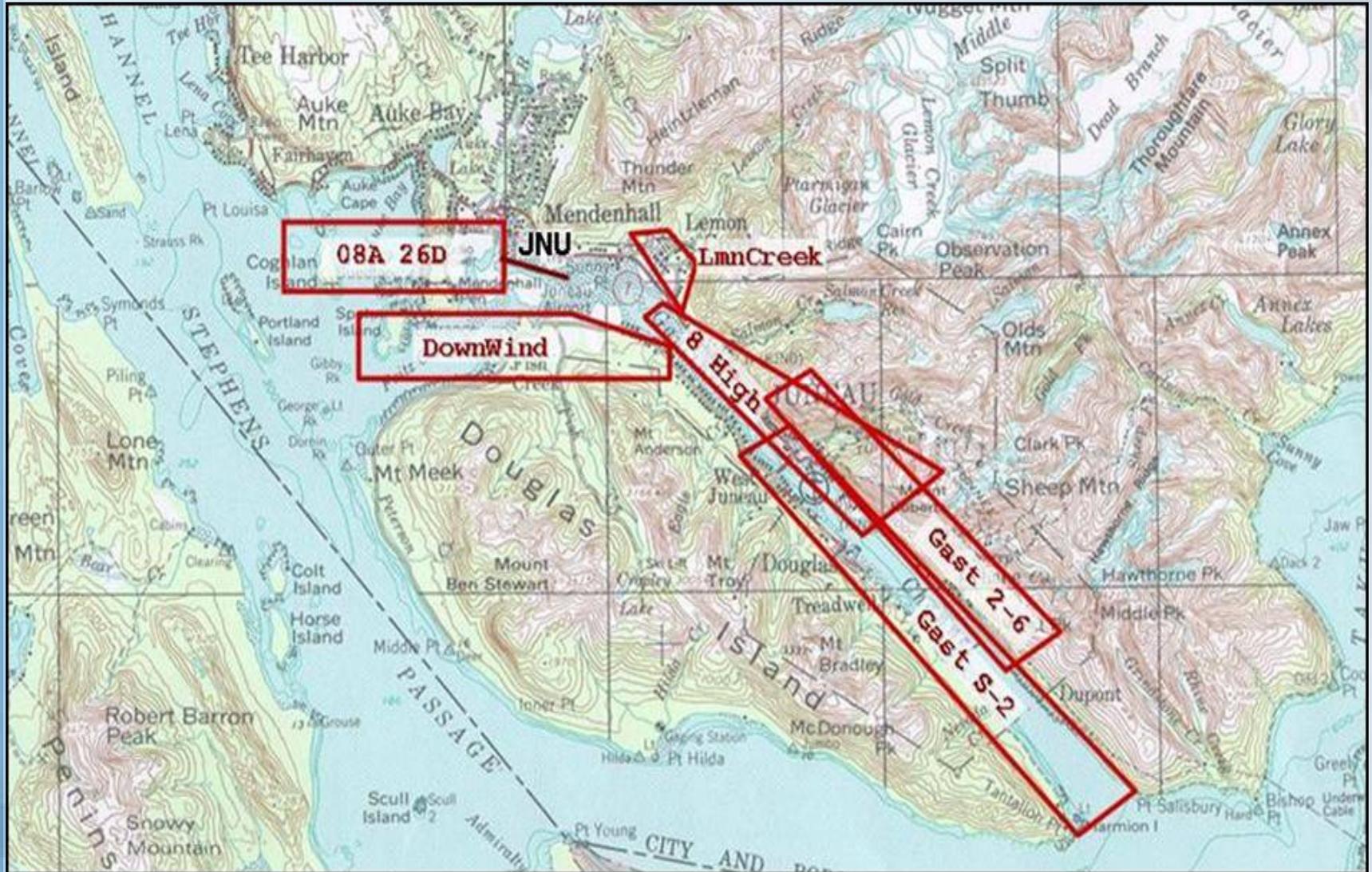
WSJ, 7 April 2008

CONUS C&V Probabilistic Forecast

Features

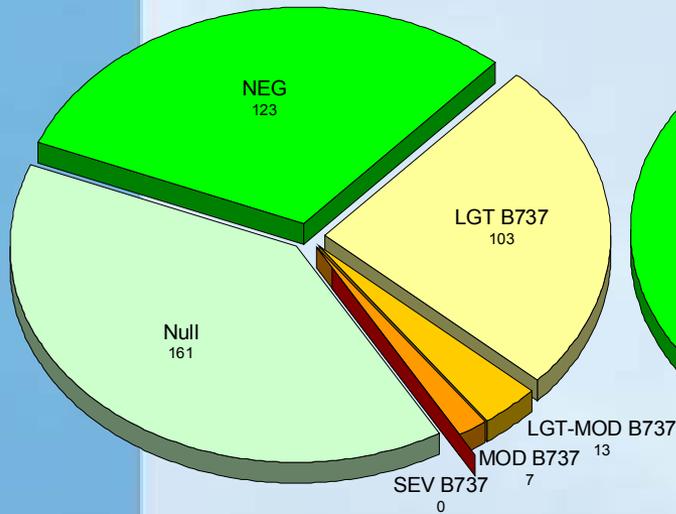
- 1-12 h forecasts initially, later extended toward 24-30 h
- Consolidates NWP, MOS, & observations-based methods
- Rapid updating, major refresh hourly, minor refresh 15-min
- 0-h diagnosis - probabilistic C&V in observation gap areas
 - uses previous 1-h probability forecast information in gap areas
 - constrained to match observations at observing points

Juneau Airport Wind System

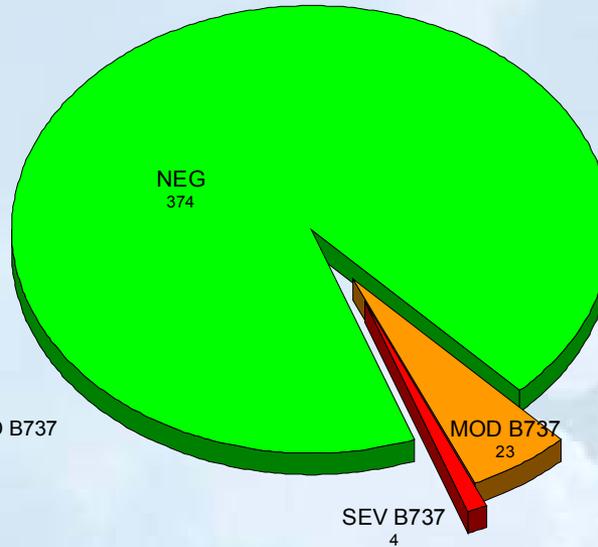


Comparison of JAWS and OpsSpec against Observations

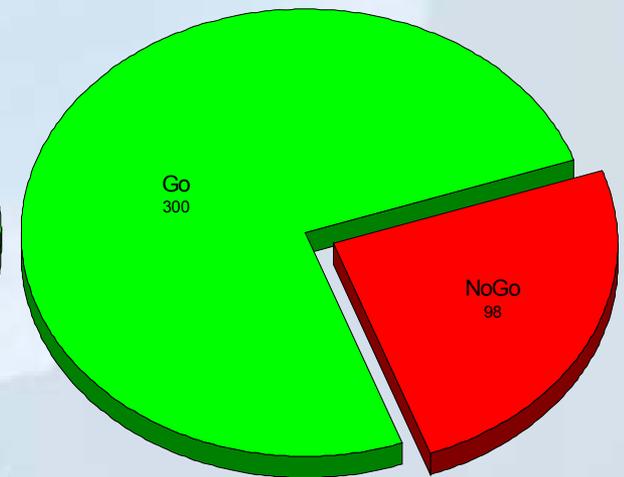
Pilots



JAWS



**OpsSpec
(RNP)**



Aviation Digital Data Service

- **Experimental ADDS**

- Ongoing support for daily operations
- Support for new product transitions
- System upgrades for better scalability, redundancy, and compatibility with AWC systems
- Implementation of new Flight Hazard Tool
- Major release to implement the above in FY2010

- **Operational ADDS**

- Ongoing support for operational problems at AWC as needed
- Support for new product transitions
- Major release to re-sync Operational and Experimental ADDS in FY2010

NextGen Network-Enabled Weather

- **Develop a comprehensive understanding of the needs and requirements of National Airspace System (NAS) decision makers, as they relate to weather data dissemination**
- **Utilize a Service Oriented Architecture (SOA) to generate a flexible, efficient approach for the delivery of weather-related data, products and services**
- **Explore and adopt open standards and specifications that meet NextGen weather data requirements**
- **Participate in national and international standards bodies (e.g., Open Geospatial Consortium)**
- **Develop a systematic, extensible implementation approach that will support additional capabilities, services, data, and products as they come online.**

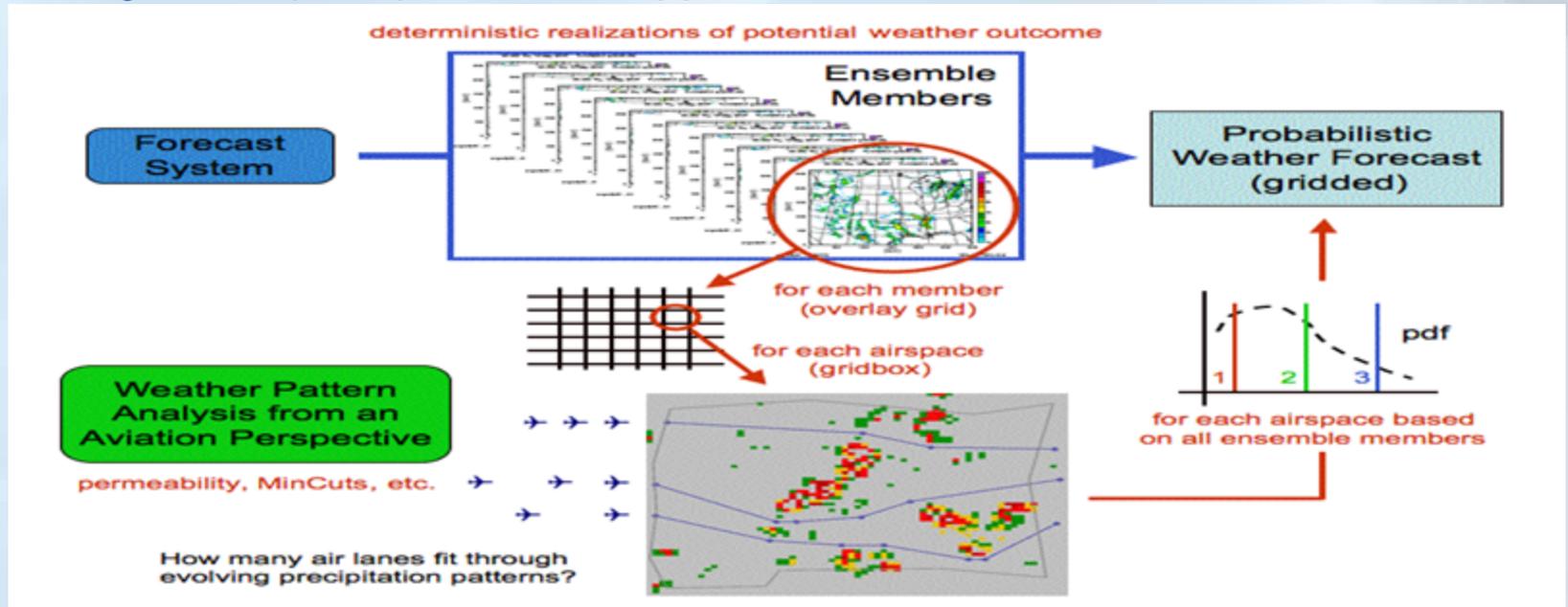
NNEW Flight Hazard Tool

- **Demonstrates example of higher level NNEW service built upon existing lower level services**
- **Web interface front end**
 - Allows definition of flight hazard query
 - Displays returned composite flight hazard
- **Web coverage service flight hazard back end**
 - Receives query from front end
 - Retrieves hazard components (turbulence, storms, icing, etc) from other WCS servers
 - Returns composite flight hazard

Probabilistic Weather & ATM

Goal:

- Creation of probabilistic scenario forecasts for integration with air traffic management (ATM) decision support tools

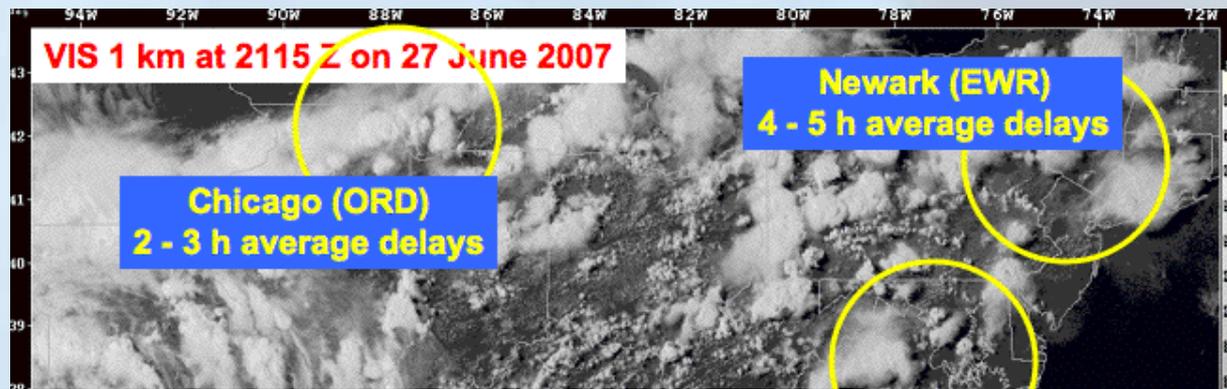


FY08 Accomplishments:

- Proof-of-concept demonstration for translation of ensemble weather forecasts into aviation impact predictions

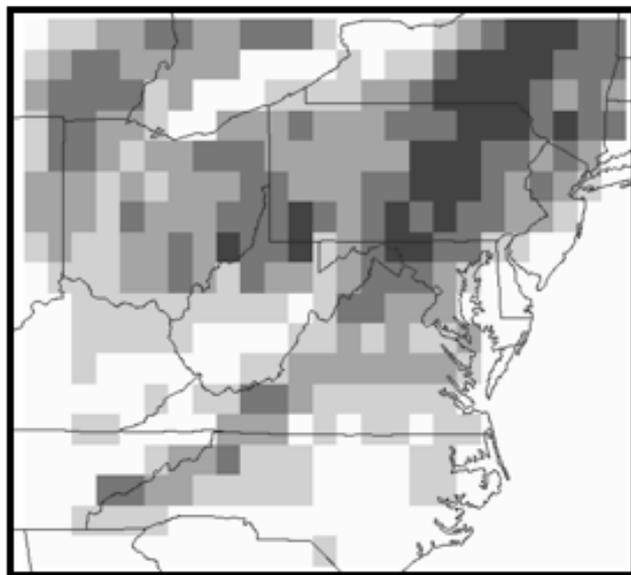
Plans for FY09:

- Expansion of analyses to include additional cases
 - focus on days with large weather impact on aviation
- Publication & presentation of results

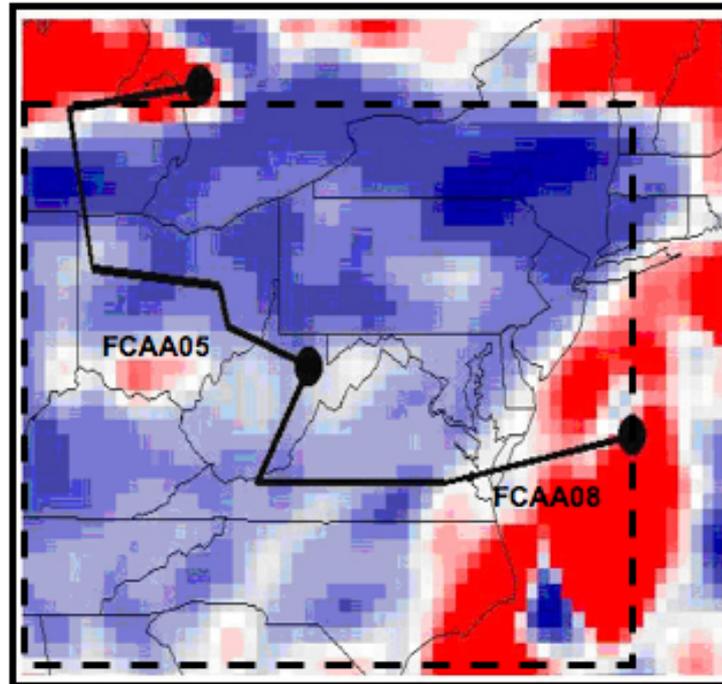


(a) Probabilistic 9-h Impact Forecast

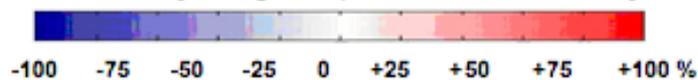
(b) Observed Air Traffic Impact



Likelihood of 30% Reduction in E-W Direction



Traffic Density Change Compared to Clear Weather Day



**Washington (DCA)
2 - 3 h average delays**

