Consolidated Storm Prediction for Aviation

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CoSPA Outline

• Inception of CoSPA
  – Consolidated Storm Prediction for Aviation

• Planned capabilities
  – 0-2 hr forecasts
  – 2-6 hr forecasts

• CoSPA roadmap to 2025
Aviation Delay Problem

- **National Delays**
  - Line graph showing delays (millions) from 1995 to 2007.
  - Dashed line represents 12 month per Mov. Avg.

- **2004-2007 Daily Wx Delay Distribution**
  - Bar graph showing normalized distribution of daily delay minutes (x10^5), mostly summer delay.

- **Aircraft Density**
  - Map showing the number of aircraft flights, with regions of high and low density.

- **Top 15 delay days**
  - Highlighted dates: June 8, June 19, June 27, July 10.
Inception of CoSPA
“Consolidated Storm Prediction for Aviation”

- **2006 Storm Prediction situation**
  - Multiple forecast systems
  - Diverse capabilities
    - Resolution, coverage, generation algorithms and display
  - Uncoordinated leveraging of FAA and NWS assets

- **CoSPA (FY 2007)**
  - Support NextGen goals
  - FAA-oriented
    - Enroute & Terminal
    - Winter & Summer
    - Fully automated
    - Meets TFM needs
  - Network enabled
  - Standardized format and access
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Corridor Integrated Weather System

- Air Traffic Control System Command Center
- Air Route Traffic Control Centers (ZAU, ZOB, ZID, ZDC, ZBW, ZNY, ZMP, ZKC)
- TRACONs (N90, C90, CVG, D21, PIT, CLE)
- Great Lakes Office
- Airlines

CONUS coverage will further CoSPA and NextGen goals and initiatives:
FAA, NWS, NASA, DoD

Transition to CONUS: June 3, 2008
0-2 hr Forecast “Demonstration”

- CIWS is initial cornerstone of CoSPA
  - Access via NNEW (NAS Network Enabled Weather)
    Available to FAA, NWS, DoD, DHS, private vendors, etc.
  - Integration with ETMS is underway
    NNEW ATOM feed
  - Highly capable web access will allow increased use
2008 Research Efforts

Data Quality Editing
Satellite Based
- Spike and Speckle Removal

Stability Mask

Front Detection

Convective Initiation

Motion Data Fusion
- Envelope
- Cell
- Satellite Winds
- NWP Winds

Improved System

Statistical Optimization

Lightning Proxy
- VIL
- Echo Tops

NOAA STMAS

NASA ASAP

Radar NWP Assimilation
- 3 km, Hourly

Blending

Weather Research-18
MMW 12/5/2007
Example of Lightning as VIL Proxy
**Enroute vs. Terminal Forecast Information**

- **System architecture goal is “complementary capabilities” (avoid duplication)**
  - National – Long range Precipitation, Echo Tops, C&V mosaics and forecasts
  - Terminal – Wind shear detection, short range ASR coverage, 3-D winds

- **Terminal linked to Enroute via service oriented architecture, web-enabled multi-scale displays**
Pilot – Convective Weather Avoidance Model

- Weather Avoidance Fields based on Precipitation and Echo Tops forecasts
- Automated deviation detection and statistical pattern classification used
- Turbulence, visual clues to be studied

Are these jet routes ‘blocked’ at 31 kft?
What capacity can be achieved?
Strategic Planning

- Strategic planning seeks to manage number of planes that flow through congested regions
- Airlines require 90 min window prior to takeoff for flight planning
  - Median lead time required = 3.5 hrs

Median Flight Time ~ 2 hr
Strategic Planning

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Current 2-6 hr Forecast Technology

- Hand drawn
- 2 hr update rate
- March – Oct. only
- Missed impacts
- Over-forecasts
- Coverage areas do not resemble wx

Forecast Coverage
Solid = 75–100%
Medium = 50–74%
Sparse = 25–49%

Forecast Confidence
High
Low
Truth

Grossly over-forecasted
Missed storms west of NYC

Convective line in wrong place
Relative Accuracy of 0-6 hr Forecast Techniques

Can we increase accuracy of 6 hr. forecasts to match today’s 2 hr forecasts?
Relative Accuracy of 0-6 hr Forecast Techniques

Can we increase accuracy of 6 hr. forecasts to match today’s 2 hr forecasts?

Relative Accuracy of 0-6 hr Forecast Techniques

- Perfect
- Little
- Current CIWS
- "Tactical"
- "Strategic"

- Increased resolution
- Numerical Models with growth & decay
- Radar data assimilation

Forecast Lead Time (hours)

0 1 2 3 4 5 6
Can we increase accuracy of 6 hr. forecasts to match today’s 2 hr forecasts?
Comparison of 13km vs. 3km Numerical Model Resolution

- 13km 9 hour fcst
- 3km 9 hour fcst
- Observed radar

13km and 3km forecasts from same initial conditions

Issued at 18Z Reflectivity valid 03Z Fri 22 Feb 2008
Numerical Model Support for CoSPA

Consolidated Storm Prediction for Aviation

- Before 2007

- CoSPA 2007-2012
  - Part of NextGen

CoSPA

NCAR

Current RUC-13 CONUS domain

Planned Rapid Refresh domain

HRRR

MIT Lincoln Laboratory

NASA

NOAA

Convective SIGMET

NCWF-2 and NCWF-6

24-6 hr CCER

TWS w/ TCWF

National CIWS

CoSPA

Current RUC-13 CONUS domain
Example of Numerical Model
3-hr Forecast

18:00
Fcst Initial Condition

21:00
3-hour Truth

21:00
3 km res.
No Radar

21:00
3 km res.
With Radar

10 July 2007
4 hr Fcst - Issued 21Z Valid 01Z

Extrapolation

Blended

HRRR

Truth

Legend:
- Extreme
- High
- Mod
- Low
4 hr Fcst - Issued 22Z Valid 02Z

Extrapolation

Blended

HRRR

Truth

- Extreme
- High
- Mod
- Low
4 hr Fcst - Issued 23Z Valid 03Z

Extrapolation

HRRR

Blended

Truth

Legend:
- Extreme
- High
- Mod
- Low
4 hr Fcst - Issued 00Z Valid 04Z

Extrapolation

HRRR

Blended

Truth

Extremes
High
Mod
Low
6 Hour Forecast Loop 20Z

6 hrs previous weather - 14Z – 20Z
6 hrs forecast weather - 20Z-02Z
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CoSPA Capabilities - Circa 2012

CONUS Integrated Sensor Mosaics
- 1 km resolution, 2.5 min update
- Precip (VIL and Surface), Echo Tops, Growth/Decay Trends, Winter Precip
  Possible new: Turbulence, Ceiling and Visibility, Surface Winds, Lightning

Animated Forecast Loops
- 0-2 hr (+ 2 hrs of past weather)
  5 min interval; 5 min update rate; 1 km resolution
- 2-6 hr
  15 min interval; 1 hr update rate; 3 km resolution

Forecast Products (all 0-6 hr)
- Deterministic Forecasts
  Precip, Echo Tops, Liquid Water Equivalent for Deicing
  Used in Summer and Winter
- Probabilistic Forecasts
  Convection, *Snow, Pilot-Weather Avoidance Fields, etc.
- Surface Fronts
  15 min update rate
- Performance Results

Coupling to TFM Decision Support
- Traffic Management System
- Route Availability Planning Tool

• Primary funding for CoSPA is from FAA Planning (Aviation Weather Research Program)
• Corridor Integrated Weather System (CIWS) is leveraging the efforts of CoSPA forecast improvements to support FAA System Operations
• CIWS + CoSPA provide near-term FAA testbed for prototyping NextGen capabilities

* Permits
  “snow – mix – rain”
  Winter Forecast
CoSPA Development Timeline

- **CONUS**
  - Improve Mosaic Data Quality
    - Add all TDWRs, Canadian
  - Develop 0-6 Hour Storm Forecasts
    - Winter/Summer
    - Deterministic
    - Probabilistic
  - Develop 0-2 hr CONUS Terminal Products
    - Deicing
    - C&V
    - Lightning Fcst
    - Winds, Wind Shift Fcst
  - Translate Forecasts into Air Traffic Capacity Impacts
    - Assess value of Turbulence and Icing Forecasts
  - Couple with Traffic Flow Management Decision Support Systems
    - Route Availability Planning Tool, ETMS
    - TFM Research Systems
  - Couple with Cockpit Data Link Systems
  - Replace and Retire Legacy 0-6 hr Forecasts

- **Add Alaska**
- **Improve 0-6 Hour Forecasts**
  - Utilize new NWS Operational Human-in-the-Loop Products
  - Utilize new geo Total Lightning Mapper, NEXRAD dual-pol data
- **Add 7-12 Hour Forecasts**
  - Advanced NWP research
- **Demonstrate New CONUS Terminal Products**
  - Deicing
  - Winds, Wind Shift Fcst
  - Ceiling & Visibility
  - Microburst Prediction
  - Lightning Fcst
  - Terminal Winds
- **Utilize Other New Sensor Capabilities**
  - ASOS, Non-federal
  - Aircraft platforms
- **Couple with TFM DSS**
- **Cockpit Data Link**
- **Retire Legacy Forecasts**

- **Add Oceanic**
- **Improve 0-12 Hour Forecasts**
- **Add 13-24 Hour Forecasts**
- **Utilize new sensor capabilities**
  - Radar
  - Satellite
  - Surface

- **Multiple Time and Area Scales**
- **Couple with TFM DSS**
- **Cockpit Data Link**

Partner with other FAA Programs:

- **SWIM**
  (System Wide Information Management)
- **NNEW**
  (NAS Network Enabled Weather)

to disseminate CoSPA Forecasts to aviation users
Summary

• CoSPA consolidates aviation 0-2 hr storm forecasts into a single system
  – Includes summer convection and winter storms
  – Multiple collaborators are contributing
  – Need multi-agency coordination

• CoSPA is partnering with FAA CIWS to ensure applicability of our forecasts
  – Further partnerships with Terminal, Enroute and developers of TFM tools will ensure functional forecast development

• High resolution, rapid update numerical modeling forms the basis for CoSPA 2-6+ hr forecasts
  – Investment in adequate computer resources is a top priority
  – Blending nowcasts and numerical forecasts will provide seamless forecasts for Aviation