Integrating Convective Wx into Air Traffic Management Decision Support Tools
July 15, 2008
Robert Beard
Overview

• Background
• What information is needed?
• Assessment– How well are we doing today?
• Notional Steps for Integration of Convective Wx
• Open Issues/Needed Research
• Summary
Integrating Convective Weather into ATM DSTs

Background–

• Dramatic rise in fuel prices, airline profitability concerns heighten demands for
  – Increased accuracy of wx prediction and consequent flight scheduling efficiency
  – Minimizing in-flight delays
  – Efficient routing around storm cells
  – Elimination of unnecessary re-routing
  – Efficient, incremental recovery after storm has cleared

• Increased congestion makes responses to predicted wx impacts even more critical
What information is needed for Air Traffic Management?

• Accurate wx forecasts (increased precision, less uncertainty)
  – Prediction of winds, icing, temps, pressure
  – Prediction of convective cells:
    • Predicted position and velocity
    • Intensity, echo tops
    • Shape
    • Growth/decay predictions
    • Uncertainty

• Enhancements to ATM Decision Support Tools to accommodate advanced wx forecasts and uncertainties
Convective wx prediction today

- Convective Wx forecasting:
  - Near-term [0-1 hr] (E.g.: TCWF, ITWS, CIWS)
  - Long-term [2-6 hr] (E.g.: Collaborative Convective Forecast Product—large uncertainties)
  - Self-assessment of accuracy can prove a valuable accuracy metric
  - Experimental collaborative convective product (Terminal) [2-5 hr]
  - Need: 0-2 hrs for avg duration flights; 2-6 hrs for planning & for longer flights
  - Well-defined “forced” cells more accurately predicted than “pop-up” convection
Integration of convective wx into today’s DSTs

• Most DSTs operational in today’s NAS:
  – Make no attempt to model dynamic convective wx cells
  – Rely on the controller/TMC to fuse data and tactically (manually) make traffic adjustments
  – Lack automation to generate suggested traffic management responses to predicted convective cells
  – Issues limiting progress
    • Accuracy and precision of convective cell predictions, especially for
      – 2+ hours
      – Pop-up cells
    • Software modifications/restructuring required for legacy DST
• Some exceptions are:
  – RAPT
  – Prototypes of TMA
  – Other R&D prototypes
Notional steps for integration of convective wx

1. Display wx cell as an overlay on ATM Situation Display
   – Real time and/or predicted
   – Controller/TMC doesn’t have to mentally superimpose, extrapolate

2. Compute blocked airspace as function of time
   – Initially as rigid simplistic volume of airspace (“moving SUA/FCA”)
   – Subsequently refine for dynamic shape and intensity

3. Auto-generate response options to blocked airspace
   – Determine alternative routing and/or configuration
   – Reduce sector/route capacity; manage impact to near-by sectors
   – Reallocate unused capacity from blockage to unaffected streams

4. Automate recovery planning for wx-impacted flights
   – Restoration profile for capacities (e.g., per aircraft capabilities)
   – Strategies for “draining” backlogged flows
Open Issues/Needed Research

- Establish/improve quantitative measures of performance:
  - Prediction accuracy for cell position, velocity, intensity, shape, growth/decay, uncertainties
  - Separation: Fully safe yet efficient separation between a/c and predicted convective wx as it forms, approaches, departs, dissipates
  - Unused capacity: Automation systems to translate Wx predictions, system status, and user demand into efficient system operations
  - Safety, efficiency operational metrics: normal ➔ degraded ➔ recovery

- Develop/enhance algorithms to re-route and flow traffic around wx problems per these performance measures

- Establish/refine data repositories permitting “replay” of actual scenario results against enhanced algorithms

- Incorporate enhanced algorithms into tactical/strategic automation for traffic control and flow management

- Analyze/document new vs old operational procedures
Summary

• Much progress made in prediction accuracy for convective wx [0-1 hr]
• Need improved accuracies for longer term prediction to permit more adequate ATM planning and response
• Need enhancements to DSTs to accommodate advancements in convective wx predictions
• Where convective uncertainties are large, incorporate probability of occurrence into flow management planning/projections