Integrating Convective Wx into Air Traffic Management Decision Support Tools

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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

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

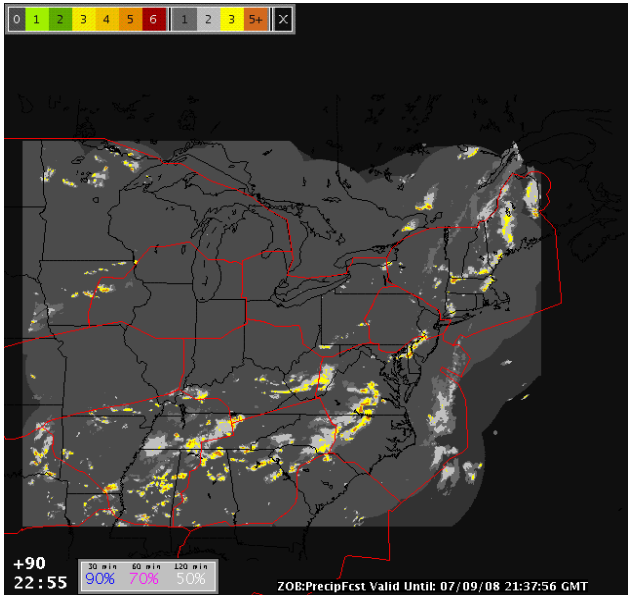
What information is needed for Air Traffic Management?

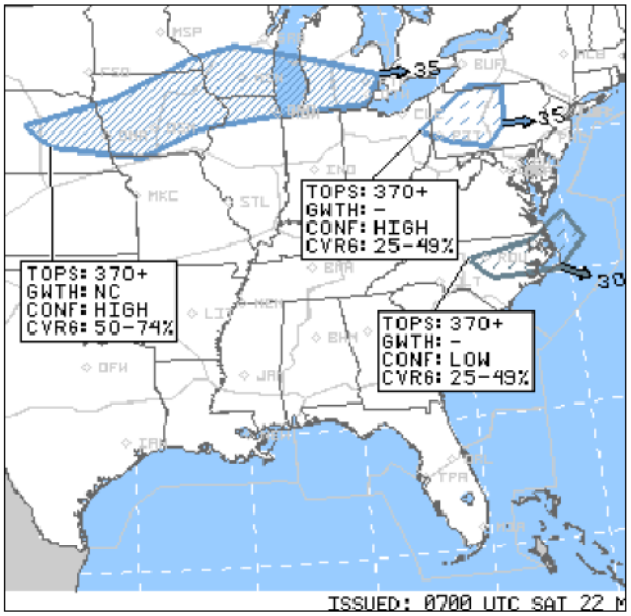
- Accurate wx forecasts (increased precision, less uncertainty)
  - Prediction of winds, icing, temps, pressure
  - Prediction of convective cells:
    - Predicted position and velocity
    - Intensity, echo tops
    - Shape
    - Growth/decay predictions
    - uncertainty
- Enhancements to ATM Decision 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