Demonstrating Feasibility of Tactical Turbulence Alerts

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Tactical turbulence project objectives

- Tactical turbulence: A rapidly-updated, high-resolution view of the current turbulent state of the atmosphere
- FAA Weather Technology in the Cockpit (WTIC) Program
- Overall research project goals
  - Identify a recommended method for presenting tactical turbulence alerts in the cockpit
  - Demonstrate the feasibility of implementing the tactical turbulence alert (with the necessary latency) via an Aircraft Access to SWIM (AAtS) connection
  - Include tactical turbulence alerting function in the Minimum Weather Service recommendations
- Three Human-Over-The-Loop (HOTL) demonstrations at the NextGen Integration and Evaluation Capability (NIEC)

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Motivation for tactical turbulence alerts

• Current information available to pilots and dispatchers inadequate to accurately identify tactical turbulence hazards and can be misleading.
  – PIREPs, *in situ* EDR reports identify turbulence after encountered by other aircraft
  – GTG forecasts on ADDS currently do not include convective (CT) or convectively-induced (CIT) turbulence
  – Radar reflectivity is related to hydrometeor size and density, not turbulence intensity
  – Convective SIGMETs are large, long-lived, and non-specific
  – Turbulence SIGMETs don’t include CT/CIT; only after severe PIREP
  – Airborne Doppler radar turbulence detection covers a limited region and is primarily for pilot use, not shared situational awareness

• Given the potentially rapid evolution of turbulence, latency of cockpit alerts must be minimized
NTDA-Graphical Turbulence Guidance Nowcast (NTDA-GTGNow)

• NTDA-GTGNow is a fusion of:
  – Graphical Turbulence Guidance (GTG-3)
    • Numerical weather prediction model
  – Diagnosis of Convectively-Induced Turbulence (DCIT)
    • MRMS 3D mosaic, lightning, satellite
  – NEXRAD Turbulence Detection Detection Algorithm (NTDA)
  – PIREPs, *in situ* EDR measurements

• NTDA-GTGNow provides diagnosis of turbulence intensity
  – Outputs eddy dissipation rate$^{1/3}$ (EDR)
  – Used to generate tactical turbulence alerts for inflight display
    • Updated at 15 min intervals
  – Includes turbulence sources for:
    • Clear air turbulence (CAT)
    • Convective (CT) and Convectively-induced turbulence (CIT)
    • Mountain wave turbulence (MWT)
Human Over The Loop (HOTL) simulations and concepts

• Three stand-alone simulations in the NIEC Research Cockpit Simulator (RCS)
  – **HOTL 1**: End-to-end system component compatibility
    • Real-time alerts computed for all commercial aircraft in CONUS, including the RCS
    • Computational server load for generating TT product and alerts
    • Latency in delivering alerts to the NIEC/RCS
  – **HOTL 2**: Effectiveness of alert information in aiding pilot decision making for cabin management
    • Archived case studies for HOTL 2 and HOTL 3 with selected flights
  – **HOTL 3**: Efficiency/appropriateness of flight decisions with and without the TT alerts and NTDA-GTGNow product displays

• Simulations will occur February-July 2015
Meteorological scenarios for HOTL 2, 3

Scenario selection criteria

- Represent different turbulence sources
  - Clear-air (CAT)
  - Convective (CT)
  - Convectively-induced (CIT)
  - Mountain-wave (MWT)
- Different areas/depths of turbulence regions
- Different times of day, including nighttime convection

NIEC Research Cockpit Simulator
(see ARAM poster 769A for more photos)
Current alert parameters (adjustable)

Width: 60 NM
Length: 100 NM
Middle: 30 NM

Position projection:
~3 minutes

NTDA-GTGNow EDR thresholds:
>0.15 Light
>0.22 Moderate
>0.34 Severe
Preliminary Text Alert Format

• Null example:
  NULL: No Alert for 18:18:00Z AIR007

• Light example:
  ALERT: 13 Oct 2014 18:48:00Z AIR007 FL400
  heading 188, Light Turbulence ahead

• Moderate example:
  ALERT: 13 Oct 2014 19:03:00Z AIR007 FL400
  heading 247, Moderate Turbulence ahead at
  JAN294021
  JAN – Nearest Navaid
  294 – Angle from Navaid to Moderate turbulence
  021 – Distance in NM
CAT – Reflectivity mosaic

Flight Plan
OKC to DEN

Alert Box

Aircraft position
CAT – Satellite visible channel

Note cloud waves
NTDA-GTGNow gridded field shown with full range of EDR values 0-1
ALERT: 05 Nov 2014 18:33:00Z AIR007 FL300 heading 312, Moderate Turbulence ahead
CAT – NTDA-GTGNNow – position 2

Null

Aircraft position
NULL: Clear at 18:48:00Z AIR007
Summary

- FAA WTIC program testing feasibility of providing tactical turbulence alerts for inflight display
  - NIEC Research Cockpit Simulator, WJHTC
  - Three HOTL simulation studies:
    - HOTL 1: End-to-end realtime system test
    - HOTL 2: Pilot decision making for cabin management
    - HOTL 3: Pilot flight decisions w/wo alerts
  - 2015 February – July time frame

- If successful, next phase for WTIC program will be a future tactical turbulence demonstration with selected airlines

Thank you!