Friends and Partners of Aviation Weather Fall Meeting

Turbulence Session

October 24, 2013

- Facilitators:
  - Bob Sharman, National Center for Atmospheric Research
  - Tammy Farrar, Federal Aviation Administration
  - Bill Watts, Delta Air Lines
Speakers

- **Bob Sharman, NCAR/Tammy Farrar, FAA**: “Aviation Turbulence Workshop Summary”
- **Steve Abelman, FAA**: “Turbulence Research in AWRP: Current Initiatives and Future Challenges”
- **Melissa McCaffrey, AOPA**: “Turbulence and the GA Pilot”
- **Melissa Thomas, DAL**: “Examples of Research Results Used to Guide Forecasting Procedures”
- **Rocky Stone, UAL**: “UAL Future Plans for Enhanced Turbulence Avoidance”
- **Bill Watts, DAL**: “Turbulence Avoidance: What Now?”
Aviation Turbulence Workshop

- Held at NCAR 28-29 Aug 2013
- 2 days
  - Day 1: Advances in detection, forecasting, and characterization of aviation-scale turbulence (18 presentations @ 20 min)
  - Day 2: Operational integration of turbulence information in airspace operations (8 presentations @ 30 min)
- Originally planned for ~30 attendees, but ended up with ~65-70
- All presentations are available for download at ftp://ftp.rap.ucar.edu/pub/sharman/Aviation_Turbulence_Workshop/
Day 1 Presentations

CIT

- **Todd Lane** (University of Melbourne, Melbourne, Australia). “Studies of near-cloud turbulence using high-resolution simulations”
- **Stan Trier** (NCAR, Boulder CO), Robert Sharman, and Todd Lane. "Influences of large-scale moist convection on turbulence in clear air ("CAT")"
- **John Williams** (NCAR, Boulder, CO). “Remote detection and statistical diagnosis of convectively-induced turbulence”
- **Wiebke Deierling** (NCAR, Boulder CO). “On the relationship of in-cloud convective turbulence and total lightning”

Observations

- **Tony Wimmers** (CIMSS, University of Wisconsin, Madison) “Identifying turbulence within satellite images: Tropopause folds and varieties of gravity waves”
- **Lukas Strauss** (University of Vienna, Vienna, Austria). "Terrain-induced turbulence: Insights gained from airborne in situ and remotely sensed data"
- **Patrick Vrancken** (DLR Oberpfaffenhofen, Germany). "The European project DELICAT - Aiming for CAT detection with airborne lidar“
- **Larry Cornman** (NCAR, Boulder CO). "Verification strategies for airborne in situ eddy dissipation rate (EDR) estimates"
Day 1 Presentations (cont.)

Upper level CAT/gravity waves
• John McHugh (Univ. of New Hampshire, Durham, NH). “Internal waves, mean flows, and turbulence at the tropopause.”
• Jim Doyle (Naval Research Laboratory, Monterey, CA). "Dynamics and predictability of deep propagating atmospheric gravity waves."
• Bob Lunnun (UKMet retired). “Does the aircraft direction of movement affect its response to turbulence?"

Low level turbulence
• Rob Fovell (UCLA, Los Angeles, CA). "Forecasting and validation of Santa Ana winds and wind gusts in San Diego"
• Teddie Keller (NCAR, Boulder CO). “Meteorological conditions contributing the crash of a Boeing 737 at Denver International Airport”

Turbulence Forecasting
• Axel Barleben (German Weather Service, Offenbach, Germany). “Improvement of EDR forecast by new terms in TKE-equation and by MOS using in situ observations”
• Philip Gill (UKMet Office, Exeter, UK). "Probabilistic turbulence forecasts from ensemble models"
• John Knox (University of Georgia, Athens, GA), Paul Williams, and Emily Wilson. “Clear Air Turbulence in a Changing World: New Results from Research and Operations”
• Jung-Hoon Kim (NASA Ames, CA) “Development of Super Ensemble Turbulence Information and Guidance (SEATIG) and its Application to Advanced Air Traffic Management (ATM) system”
Highlights of Day 1

• Progress is being made in fundamental understanding of out-of-cloud CIT (NCT) but it is complicated and we are not yet at the point where we could advise on changes to FAA turbulence avoidance guidelines
• Recent studies of low-level turbulence shows a highly dynamic and site-specific character
• Big effort in Europe to resurrect forward-looking lidar
• Recent climate change studies have indicated an increase and shift northward of turbulence zones over the N. Atlantic
• NASA/contractors are beginning to incorporate turbulence probabilistic forecasts into automated route-planning systems
Proportion of along-line volume that is turbulent (TKE>0.25 m²/s²)

Thunderstorm line simulation
8000x1220x334 @75 m
Courtesy Todd Lane

Cloud boundary 0.1g/kg
Reflectivity boundary 5 dBz
Observations of Santa Ana wind gusts

(1830Z 15 Feb 2013)
Day 2 Presentations

• **Steve Abelman**, FAA/AWD-Weather Research Branch, “Impacts and Challenges of Turbulence Observing and Forecasting - Setting the Stage for Today's Workshop"

• **Tim Rahmes**, Boeing, “Boeing Perspective on Turbulence”

• **David Holly**, Supervisory Traffic Management Coordinator, Atlanta ARTCC, “Turbulence in the National Airspace System”

• **Rocky Stone**, UAL, RTCA, “Cockpit requirements for turbulence information”

• **Bill Watts**, Delta Air Lines, “Operational Use of GTG and EDR”

• **Melissa McCaffrey**, Aircraft Owners and Pilots Association, “Turbulence and the GA Pilot”

• **Ian Gray**, SITA/Senior Portfolio Manager, Flight Briefing Services, “Pre-flight and in-flight use of CAT forecasts”

Highlights of day 2

- Turbulence can have a significant effect on National Airspace System (NAS) operations (routing/altitude changes, loss of speed control as aircraft spacing tool, increased holding)
Highlights of day 2

- Turbulence information must be tailored to user needs, especially for in-flight use (convective initiation/cloud tops, nowcasts)

DAL Tablet Turbulence Viewer-Profile View
Highlights of day 2

• The use of flight tests for improving integration of turbulence information into operations has important benefits (sensor and application improvement, network security and data link demonstrations, interagency cooperation)

• Process for getting improvements to users can be slow and cumbersome. The need for a good business case exists throughout the community (industry and developers)

• Challenges: Probabilistic vs deterministic, strategic vs tactical, commercial carriers vs. GA, limits of the science, human in/over the loop, policy/proprietary issues (data-sharing), global harmonization

• GOOD OPEN DISCUSSION!
Next Steps

- Feedback on the workshop has been overwhelmingly positive
- Recurring activity? How often? Location? Number of days?
- Expansion of participant base?
  - More global participation
  - Commercial developers
- FPAW inputs welcome!
Questions?