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 Summary
National Center for Atmospheric Research (NCAR)
Boulder, CO; August 28-29, 2013
Presented by: Bob Sharman, NCAR/RAL
Tammy Farrar, FAA Aviation Weather Division

Date: Oct 24, 2013

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 Lunnon (**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*"*
- **Bob Sharman (**NCAR, Boulder, CO). "New developments in the Graphical Turbulence Guidance product"
- **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
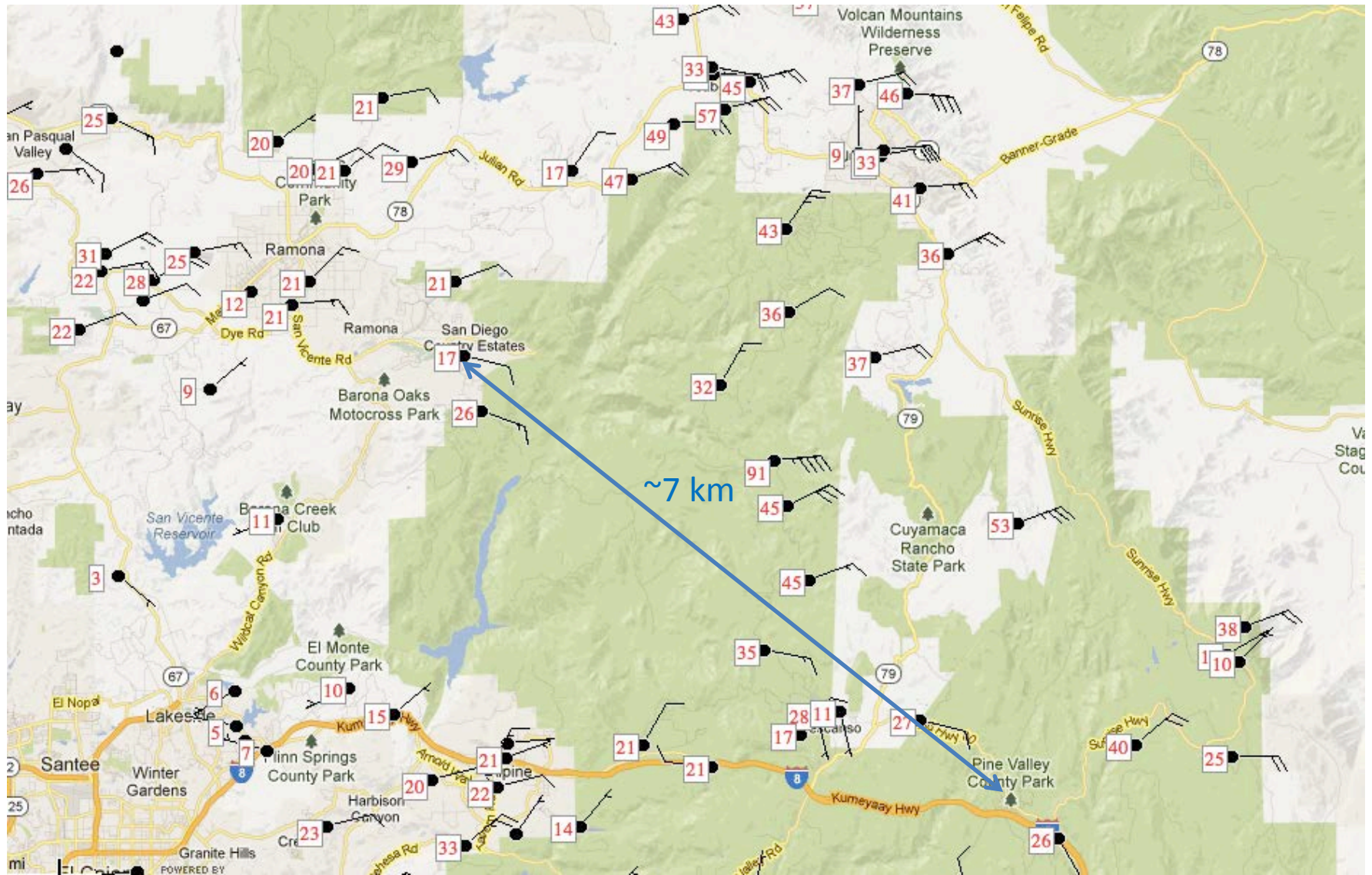
Vertical velocity @ 10 km (m/s)
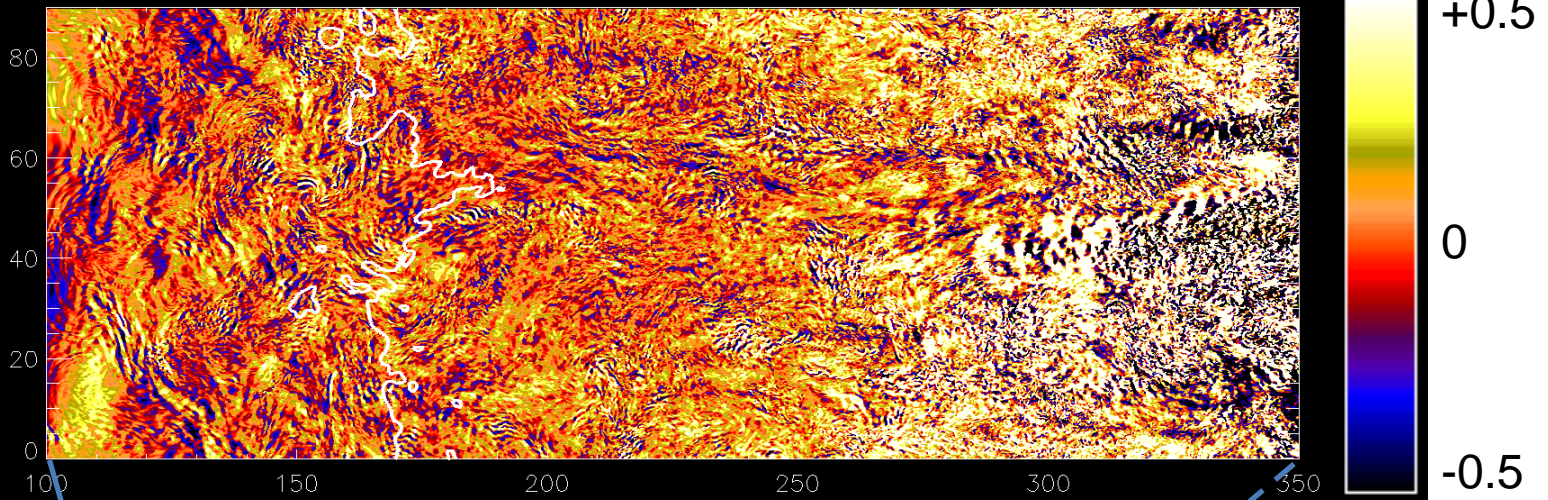
Proportion of along-line volume that is turbulent (TKE>0.25 m²/s²)

Thunderstorm line
simulation
8000x1220x334
@75 m
Courtesy Todd Lane

Cloud boundary 0.1g/kg

Reflectivity boundary 5 dBz
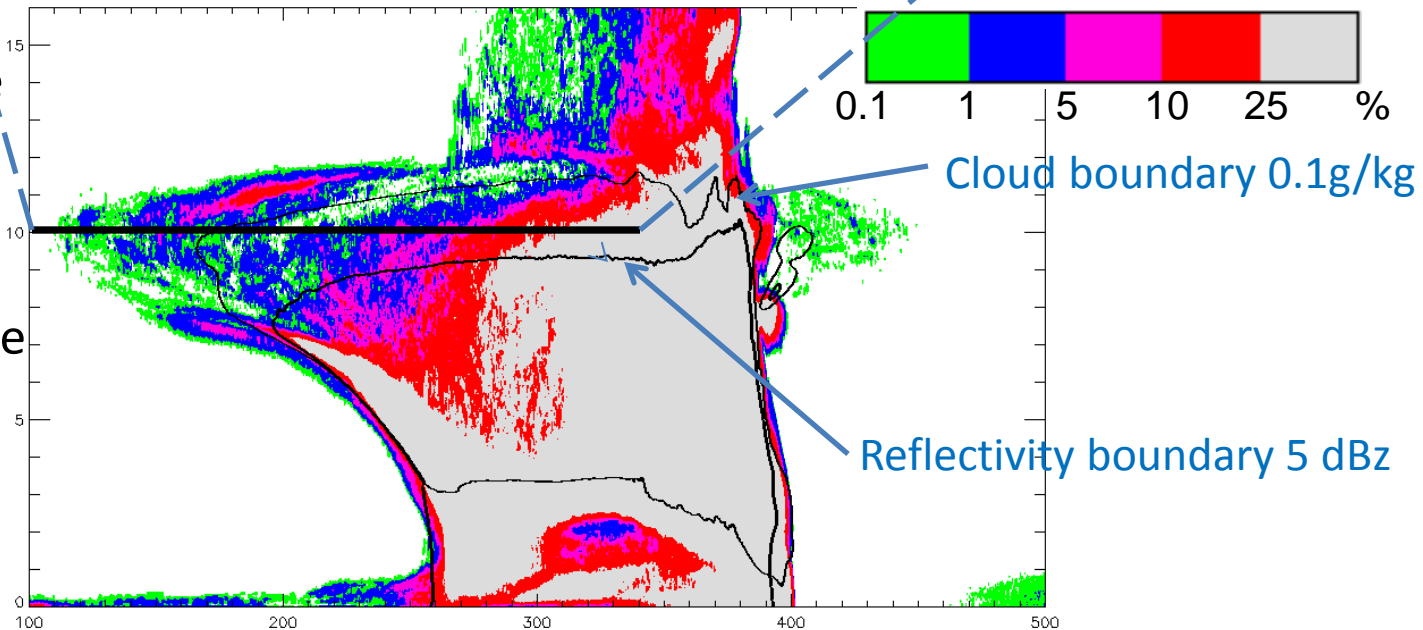
Observations of Santa Ana wind gusts

(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"
- **Steve Albersheim,** FAA/AWD-Policy and Requirements Branch, "World Area Forecast System New Global Gridded Forecasts"
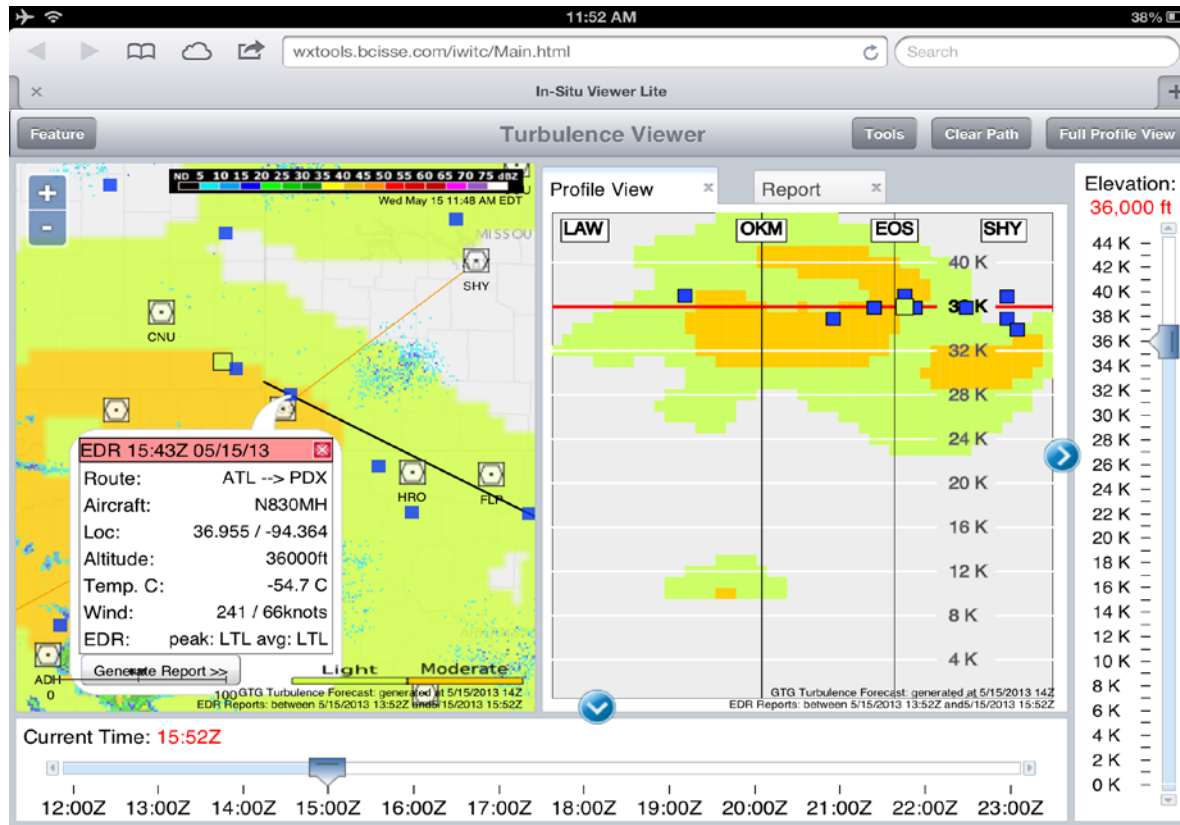
Highlights of day 2

- 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)

7/3/13 2010z – Moderate reported

7/3/13 2015z – holding
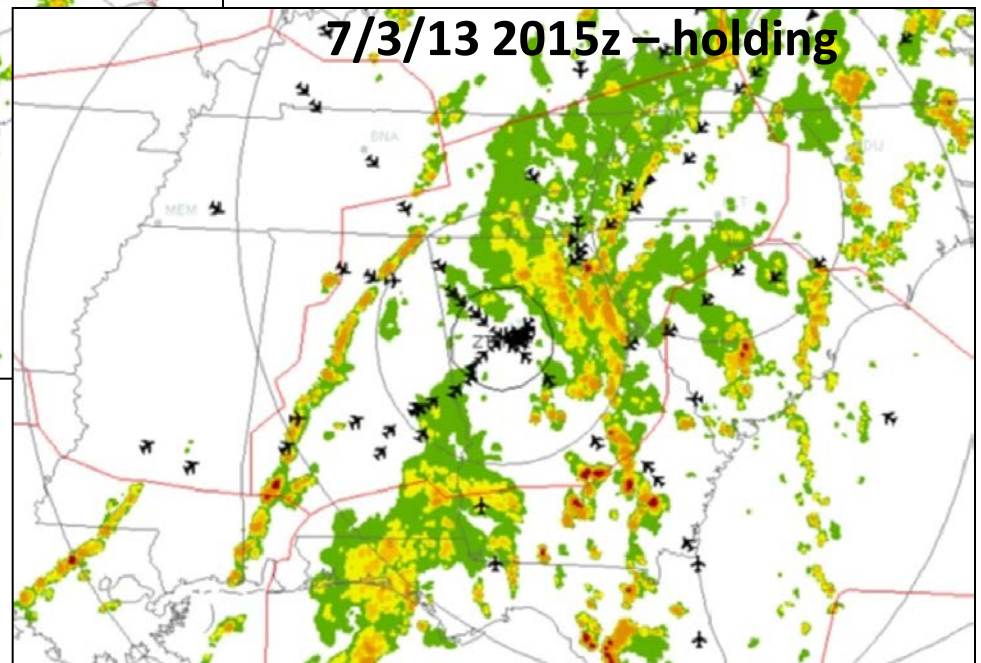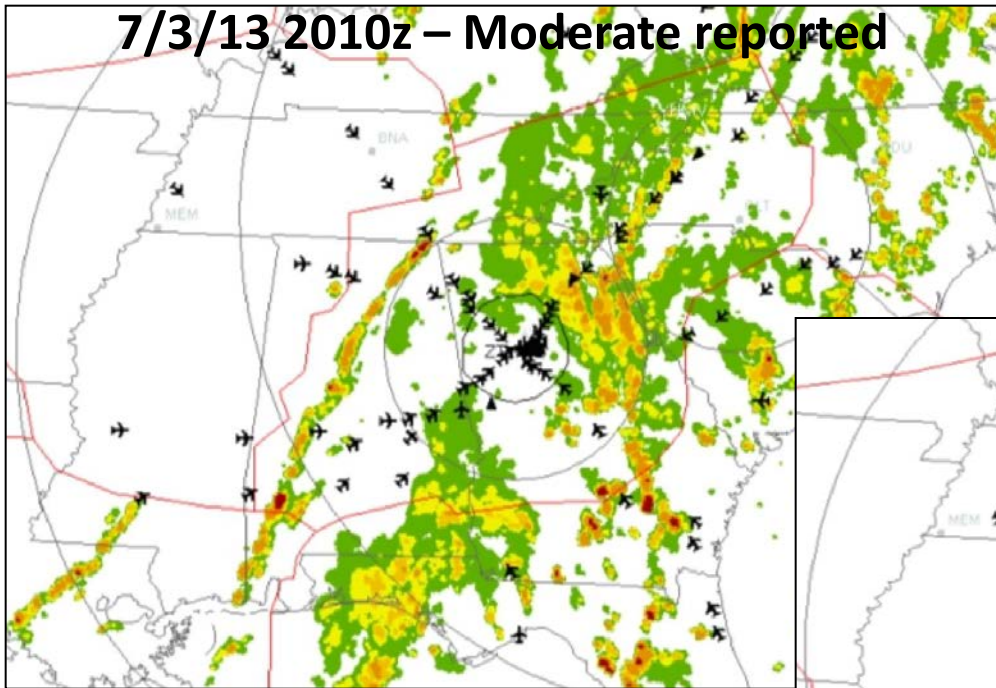
Highlights of day 2

- 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?