National Transportation Safety Board

Preventing Turbulence-Related Injuries in Part 121 Air Carrier Operations and Why is this Important?

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Why the NTSB Did This Research

- Turbulence-related accidents are the most common type of Part 121 accident
- From 2009 through 2018:
  - Turbulence accounted for 111 of 295 Part 121 accidents (38%)
  - All resulted in at least one serious injury

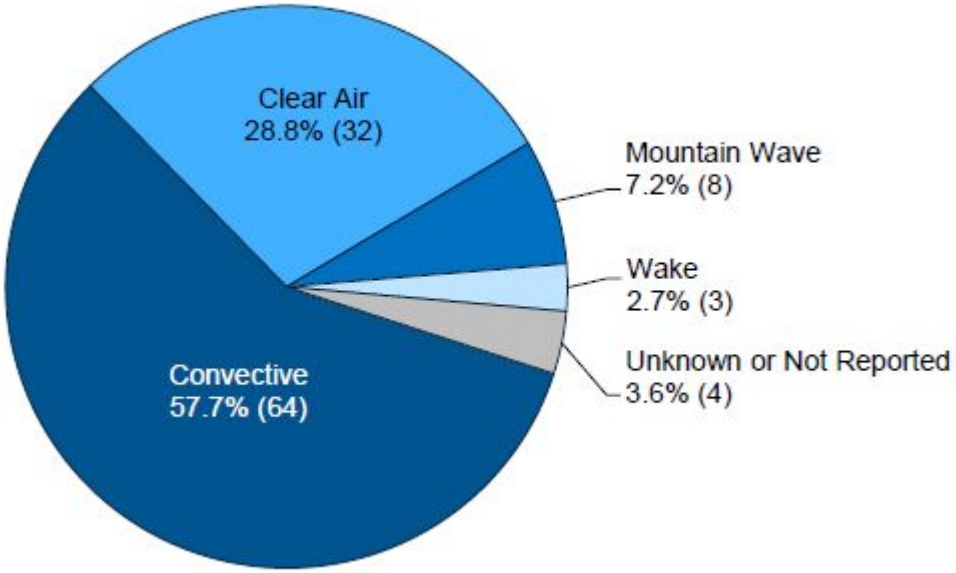
Defining Events Ranked by FAR Part

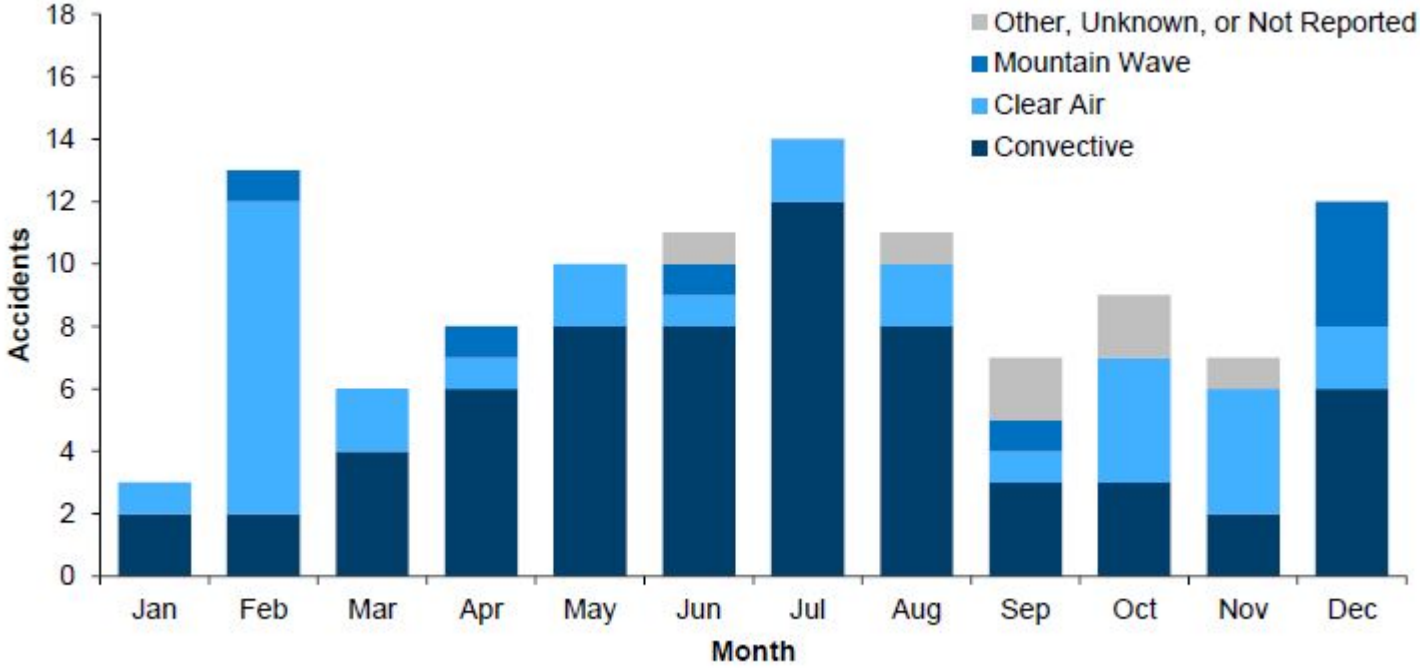
General Aviation		
1	Loss of Control-Inflight	18%
2	Powerplant Malfunc	18%
3	Loss of Control-Ground	14%
4	Abnormal Rwy Contact	13%
5	Fuel	5%
⋮	⋮	⋮
⋮	⋮	⋮
21	**Turbulence**	**<1%**

Part 135		
1	Powerplant Malfunc	15%
2	Loss of Control-Inflight	14%
3	Abnormal Rwy Contact	12%
4	Loss of Control-Ground	9%
5	Non-Powerplant Malfunc	8%
⋮	⋮	⋮
14	**Turbulence**	**1%**

Part 121		
1	**Turbulence**	**34%**
2	Ground Collision	14%
3	Abnormal Rwy Contact	10%
4	Cabin Safety Event	9%
5	Ground Handling	9%

- 2008-2016 US civil aviation accidents
- Defining events from 32-category CAST/ICAO taxonomy


Clear Air
28.8% (32)
Mountain Wave
7.2% (8)
Wake
2.7% (3)
Unknown or Not Reported
3.6% (4)
Convective
57.7% (64)


Other, Unknown, or Not Reported
Mountain Wave
Clear Air
Convective
Accidents
0
2
4
6
8
10
12
14
16
18
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

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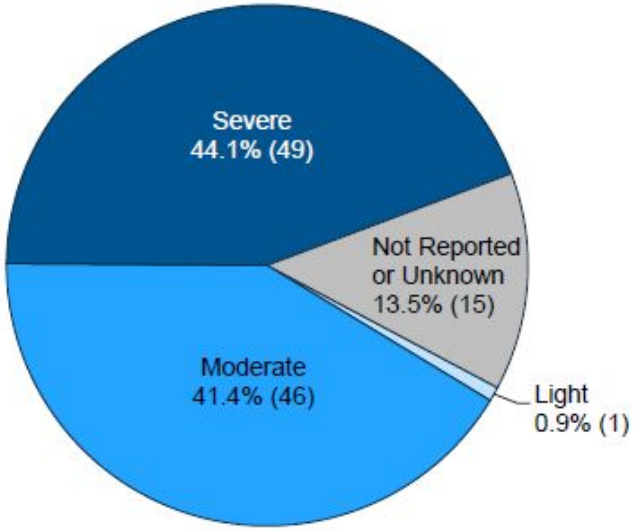
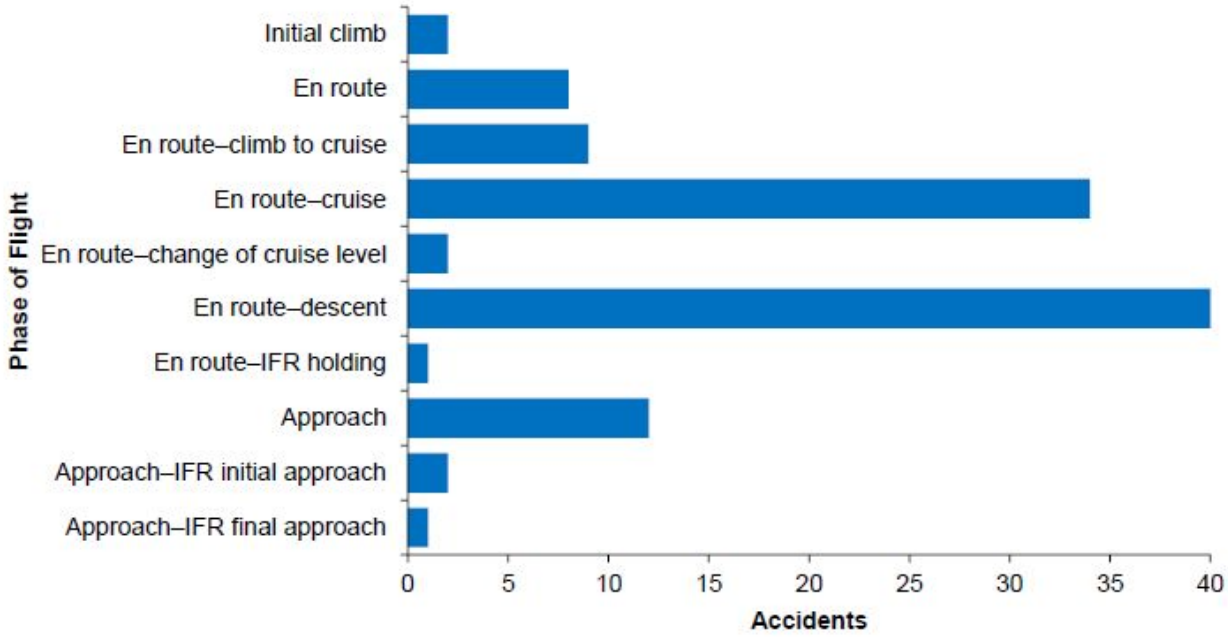
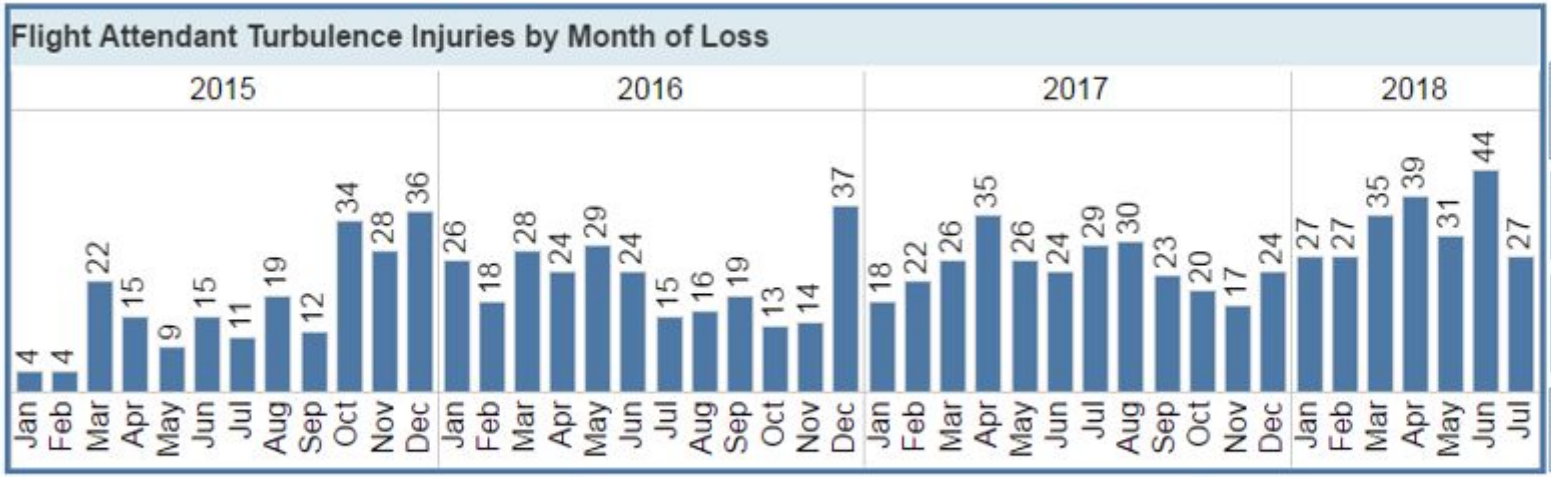

Severe
44.1% (49)
Not Reported
or Unknown
13.5% (15)
Moderate
41.4% (46)
Light
0.9% (1)


Initial climb
En route
En route–climb to cruise
En route–cruise
En route–change of cruise level
En route–descent
En route–IFR holding
Approach
Approach–IFR initial approach
Approach–IFR final approach
Phase of Flight
0
5
10
15
20
25
30
35
40
Accidents

American Airlines Flight Attendant Turbulence Injury Dashboard



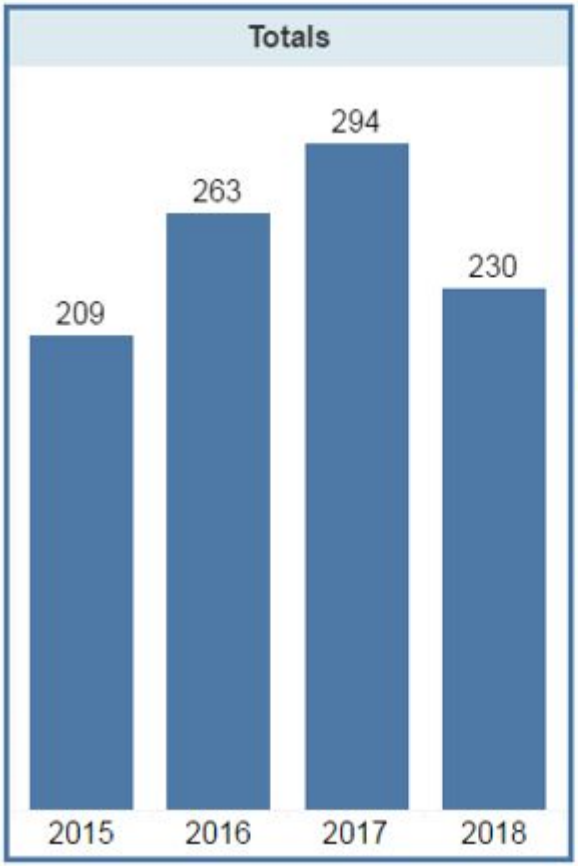
Available Filters

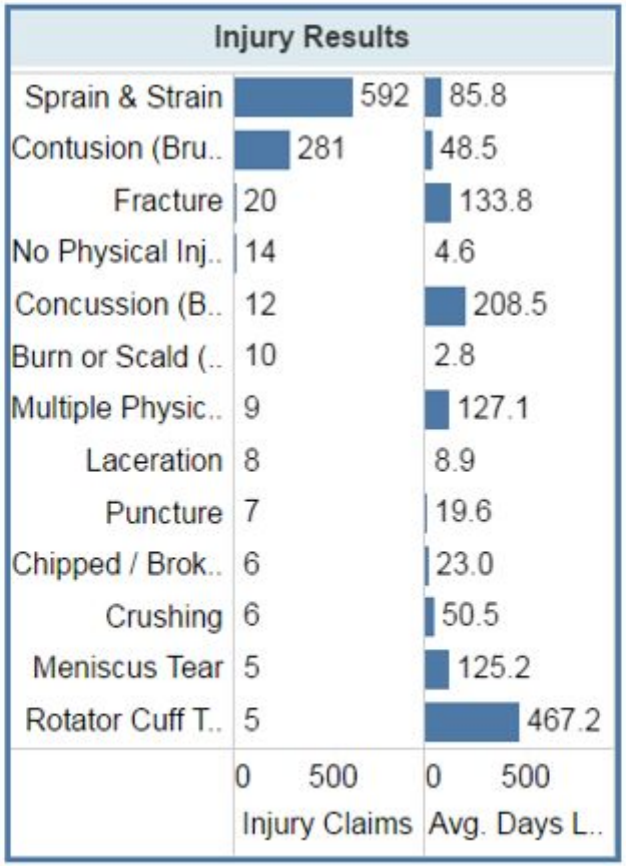
Year of Loss: (All)

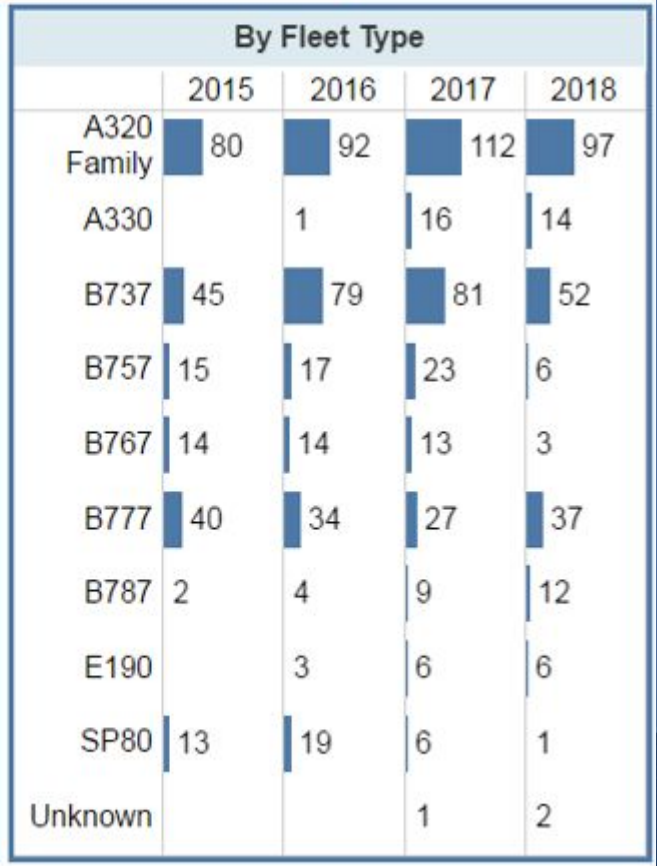
Month of Loss: (All)

Base: (All)

Claim Status: (All)







EDR reported by DL957

DL957 FL350 0000Z 36.22N/87.48W
DL957/OV 36.22N087.48W/FL350/TM 0000/TP B737/TA -50.0/WV 25135/TB NEG/CP KBZN-KATL/RM EDR=0.00/0.02
Rcvd: 2/18/2019 00:05Z

DL957 FL350 0001Z 36.13N/87.33W
DL957/OV 36.13N087.33W/FL350/TM 0001/TP B737/TA -50.2/WV 25134/TB NEG/CP KBZN-KATL/RM EDR=0.00/0.00
Rcvd: 2/18/2019 00:05Z

DL957 FL350 0002Z 36.05N/87.19W
DL957/OV 36.05N087.19W/FL350/TM 0002/TP B737/TA -50.5/WV 25130/TB NEG/CP KBZN-KATL/RM EDR=0.00/0.02
Rcvd: 2/18/2019 00:05Z

DL957 FL342 0003Z 35.96N/87.04W
DL957/OV 35.96N087.04W/FL342/TM 0003/TP B737/TA -49.0/WV 25128/TB NEG/CP KBZN-KATL/RM EDR=0.00/0.00
Rcvd: 2/18/2019 00:05Z

DL957 FL329 0004Z 35.87N/86.92W
DL957/OV 35.87N086.92W/FL329/TM 0004/TP B737/TA -46.0/WV 25125/TB LGT/MOD/CP KBZN-KATL/RM EDR=0.08/0.18
Rcvd: 2/18/2019 00:05Z

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DL957/OV 35.77N086.79W/FL316/TM 0005/TP B737/TA -42.0/WV 25122/TB NEG/CP KBZN-KATL/RM EDR=0.02/0.04
Rcvd: 2/18/2019 00:11Z

DL957 FL307 0006Z 35.67N/86.67W
DL957/OV 35.67N086.67W/FL307/TM 0006/TP B737/TA -39.0/WV 25121/TB OCNL LGT/CP KBZN-KATL/RM EDR=0.04/0.08
Rcvd: 2/18/2019 00:11Z

DL957 FL290 0007Z 35.57N/86.55W
DL957/OV 35.57N086.54W/FL290/TM 0007/TP B737/TA -35.2/WV 25109/TB OCNL LGT/CP KBZN-KATL/RM EDR=0.04/0.08
Rcvd: 2/18/2019 00:11Z

DL957 FL269 0008Z 35.48N/86.42W
DL957/OV 35.48N086.42W/FL269/TM 0008/TP B737/TA -29.7/WV 25107/TB OCNL LGT/CP KBZN-KATL/RM EDR=0.04/0.06
Rcvd: 2/18/2019 00:11Z

DL957 FL250 0009Z 35.39N/86.31W
DL957/OV 35.39N086.31W/FL250/TM 0009/TP B737/TA -24.5/WV 25100/TB OCNL LGT/CP KBZN-KATL/RM EDR=0.04/0.10
Rcvd: 2/18/2019 00:11Z

DL957 FL250 0010Z 35.3N/86.2W
DL957/OV 35.30N086.20W/FL250/TM 0010/TP B737/TA -24.7/WV 24092/TB LGT/CP KBZN-KATL/RM EDR=0.08/0.14
Rcvd: 2/18/2019 00:11Z

DL957 FL240 0013Z 35.04N/85.88W
DL957 /OV 35.04N085.88W/FL240/TM 0013/TP B737/TA -23.0/WV 24108/TB NEG/CP KBZN-KATL/RM EDR=0.02/0.04
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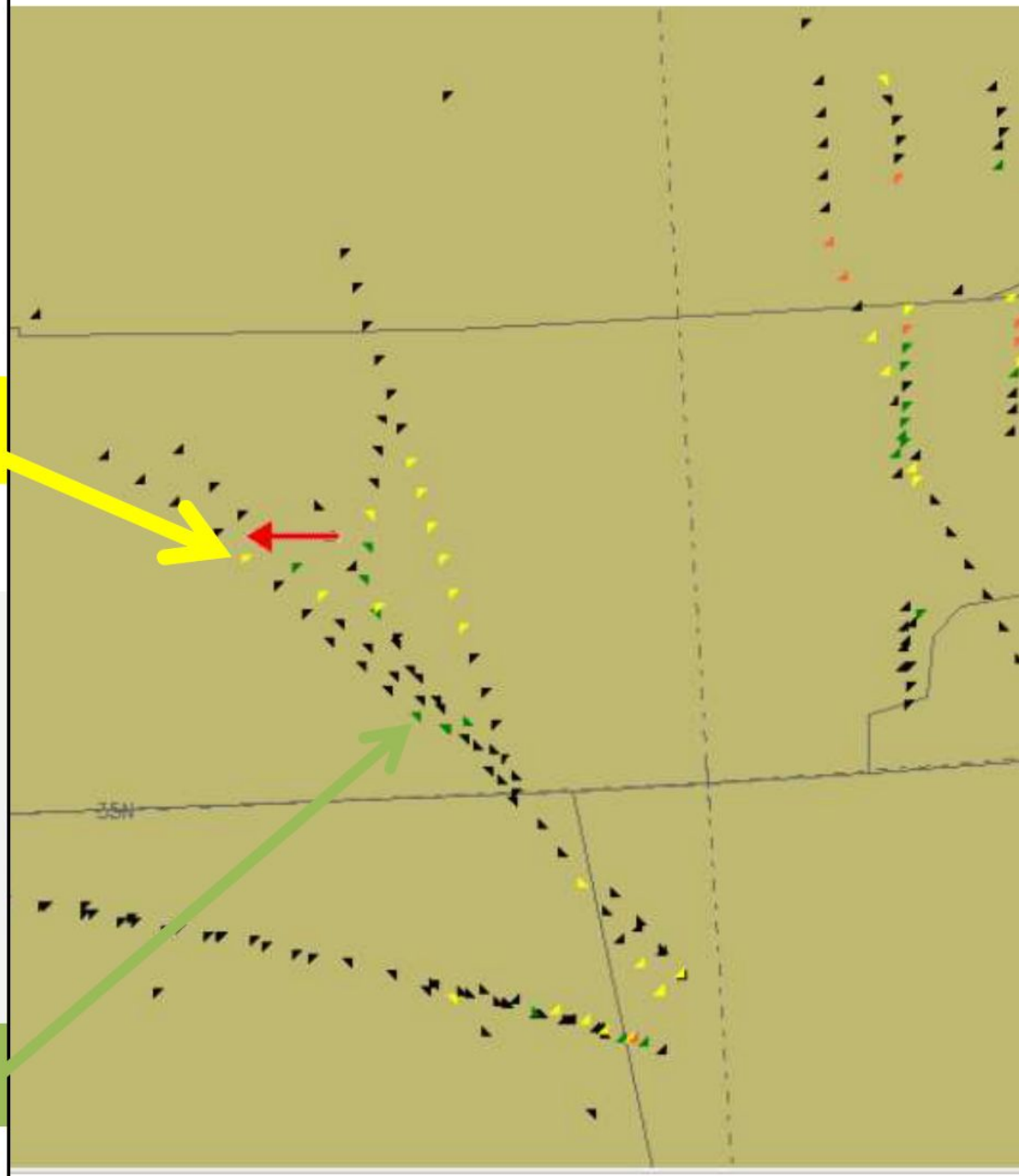
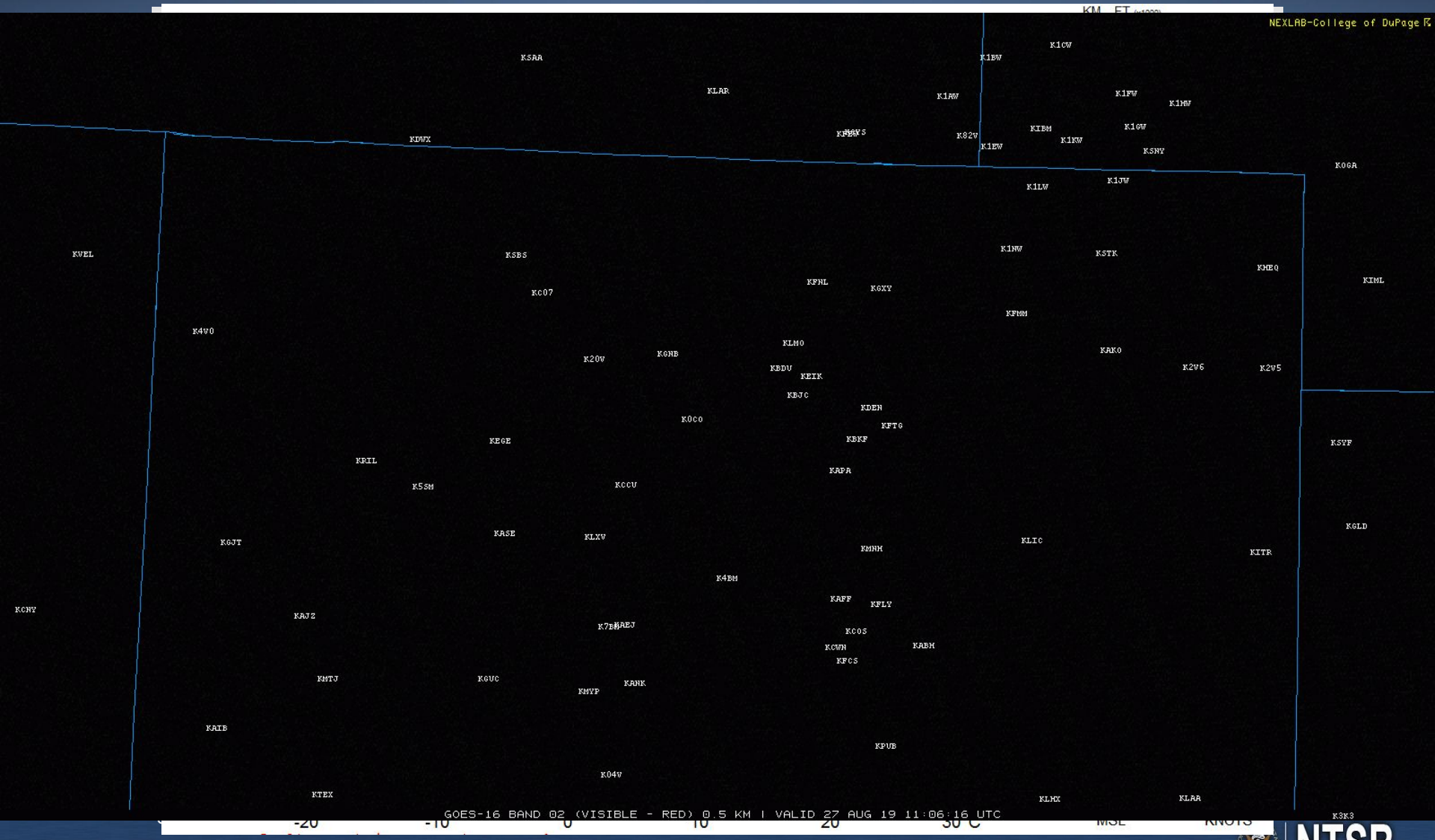


DCA19CA206 near Denver, Colorado at FL150



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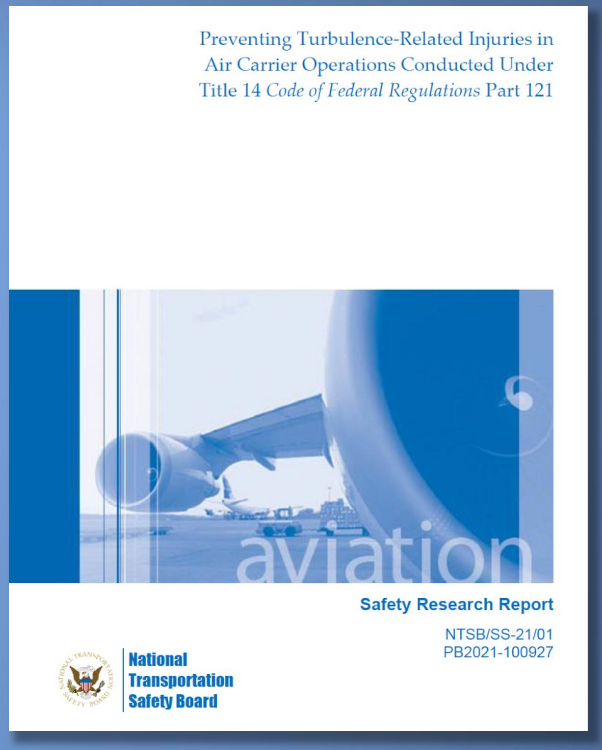
Part 121 Turbulence Safety Research Report

- Published September 2021
- Issued 21 new safety recommendations
  - 18 to FAA
  - 2 to NWS
  - 1 to A4A, NACA, and RAA
- Reiterated 4 recommendations to FAA



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Research Methodology

- Literature review
- Data analysis
- Case studies
- Stakeholder interviews
  - Federal Aviation Administration (FAA)
  - Air traffic control (ATC)
  - Air carriers
  - Meteorologists and commercial weather information providers
  - Pilot and flight attendant unions
  - Aircraft and airborne radar manufacturers

Safety Issue Areas

- Insufficient submission and dissemination of turbulence observations
- Lack of shared awareness of turbulence risks
- Need for mitigation of common turbulence-related injury circumstances
- Need for updated turbulence guidance

PIREPs

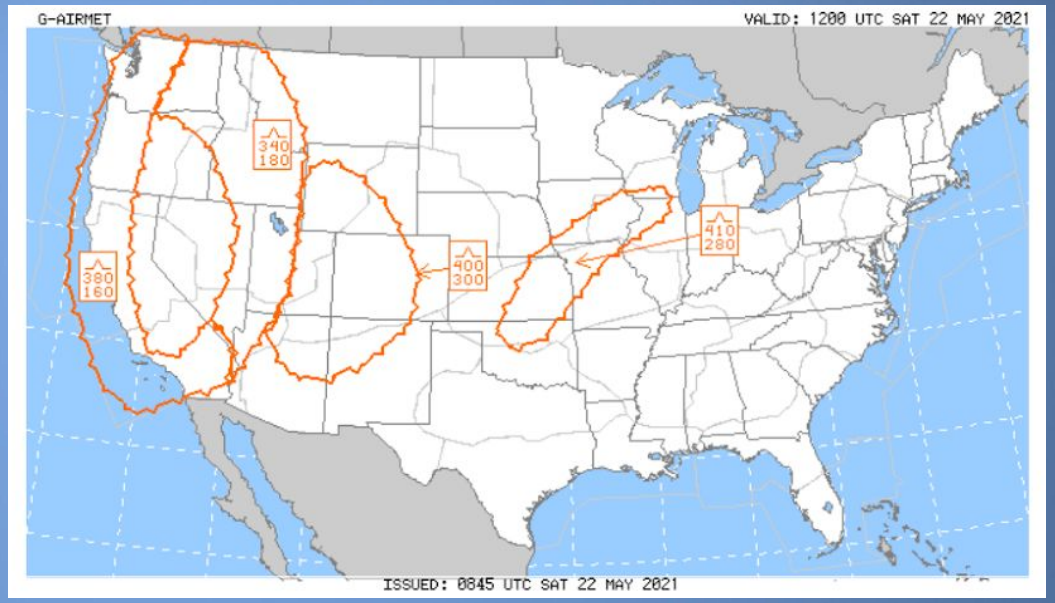
- PIREP information, such as “smooth ride” or “light turbulence,” though routinely provided was rarely disseminated
- In 2018, less than 10% of transmissions containing weather information made by pilots to ATC resulted in a PIREP

Automatic Dependent Surveillance – Broadcast (ADS-B)

- ADS-B Weather (Wx)
  - Weather broadcast capability via ADS-B data link
- ADS-B Wx PIREP
  - PIREP broadcast capability with EFB
- ADS-B Wx AIREP
  - AIREP continuous broadcast capability

Concerns with AIRMETs

- AIRMETs of limited value due to size
- Turbulence difficult to capture within limited AIRMET formats



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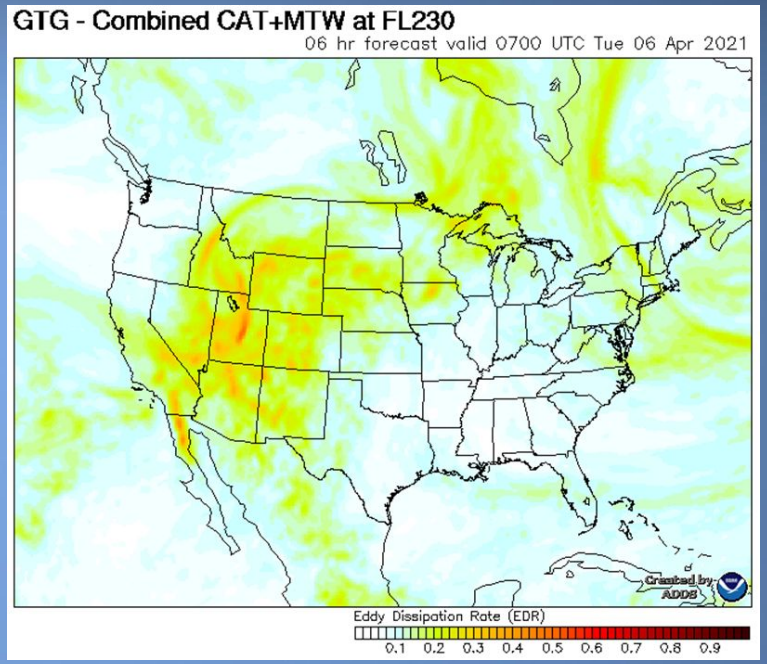
Turbulence Tools for Tactical Decision-Making

- Turbulence reports do not allow for proactive turbulence avoidance
- Graphical Turbulence Guidance (GTG) hourly update rate
- Graphical Turbulence Guidance Nowcast (GTGN) not operational



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Common Injury Circumstances

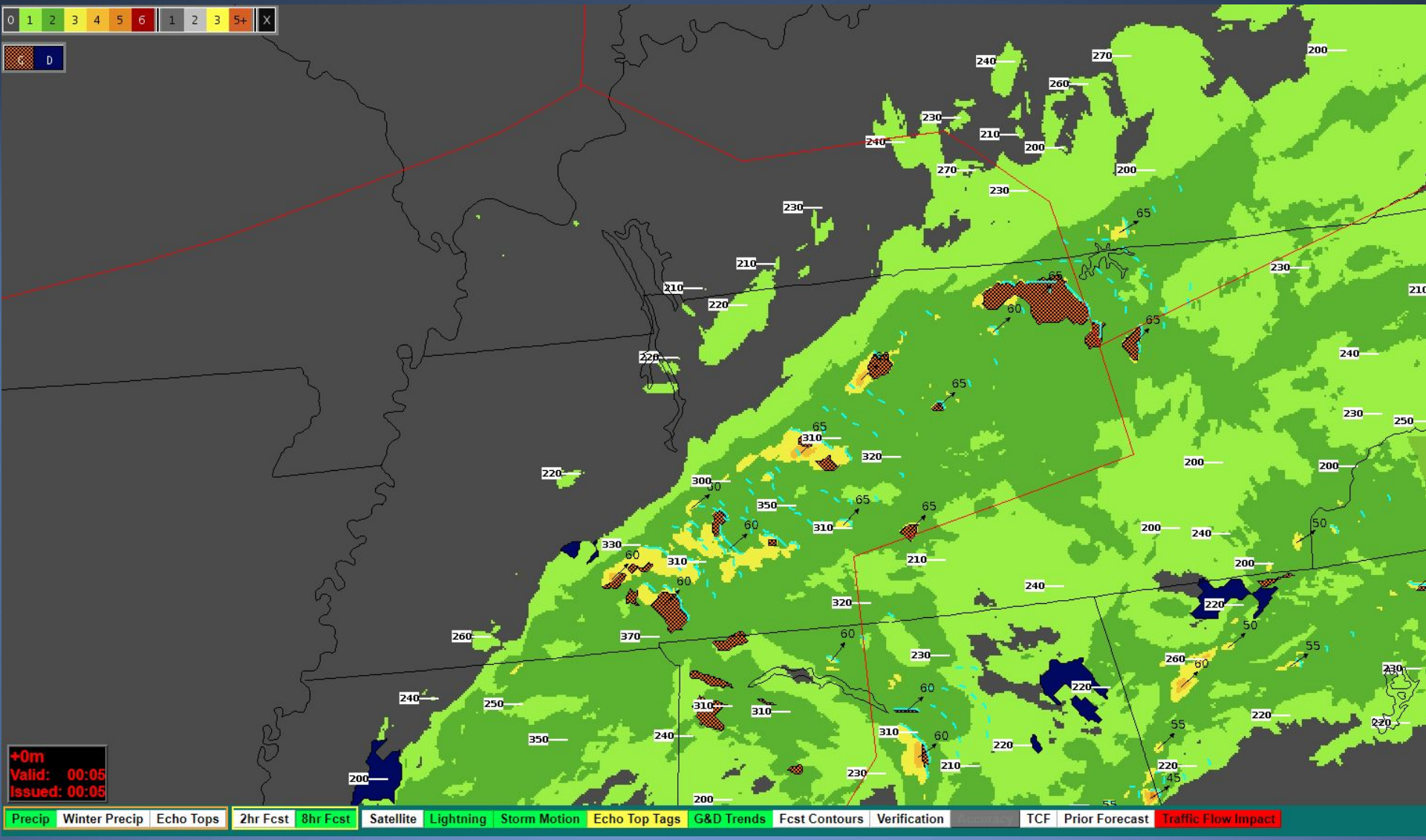
- In 28% of Part 121 accidents, flight crew had no warning of turbulence
- Injury data show
  - Occupants not wearing a seat belt
  - Occurred during descent
  - Locations are not uniformly distributed throughout the cabin

SAWS in ABQ

- Why should I care about part 121?

Safety Recommendations (paraphrased)

- Provide controllers with automated PIREP data-collection tools (FAA, reiteration)
- Populate PIREPs with data captured from controller displays (FAA, reiteration)
- Standardize distribution of PIREPs within ATC facilities (FAA)
- Provide a means of electronically accepting PIREPs from all users
  (FAA, reiteration)
- Require air carriers to disseminate all turbulence observations to the NAS as a condition of EWINS approval (FAA)
- Encourage industry efforts to incentivize PIREP sharing (FAA, reiteration)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Precip Winter Precip Echo Tops
2hr Fcst 8hr Fcst
Satellite Lightning Storm Motion Echo Top Tags G&D Trends Fcst Contours Verification Accuracy TCF Prior Forecast Traffic Flow Impact

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Safety Recommendations (paraphrased)

- Provide guidance on phases of flight and altitudes at which flight attendants should be seated, in particular during descent (FAA)
- Study how aircraft accelerations vary along the length of the aircraft during turbulence (FAA)
- Update turbulence Advisory Circular (FAA)

Safety Recommendations (paraphrased)

- Determine how to harmonize current and future EDR algorithm performance in operational environments and publish the results of this determination (A-21-27 to FAA)
- Incorporate the ADS-B Wx capability in the next version of the ADS-B TSO (A-21-28 to FAA)
- After the ADS-B TSO is revised as recommended in A-21-28, require that aircraft flown in Part 121 operations be retrofitted with ADS-B Wx capable equipment (A-21-29 to FAA)
- Require ADS-B Wx equipped aircraft to broadcast ADS-B Wx information when operating in airspace requiring ADS-B capability as defined by 14 *CFR* 91.225 (A-21-30 to FAA)

For More Information

- Report
  - www.ntsb.gov » Safety Research » Safety Research Reports
- Board meeting presentations
  - www.ntsb.gov » News and Events » Events & Training
- Paul.Suffern@ntsb.gov

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