The Increasing Threat of Turbulence

Moderator:
- **Captain Brent King**, Head, Flight Operations Efficiency, IATA

Panelists:
- **Richard Niland**, Senior Flight Operations Engineer & EFB Administrator, Aer Lingus
- **Captain Rich Terry**, Managing Director of Line Operations, Delta Air Lines
- **Katya Vashchankova**, Head MET Program, IATA
- **Paul Williams**, Professor of Atmospheric Science, Reading University
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Is climate change increasing turbulence?

Professor Paul D. Williams, Ph.D.

University of Reading, UK
Number of serious injuries (including fatalities) caused by turbulence, per million flight departures (US carriers)
Number of flight attendant injuries caused by turbulence, per million hours flown (US carriers)

[Graph showing the number of flight attendant injuries caused by turbulence, per million hours flown (US carriers) from 1992 to 2001. The graph includes data for minor, serious, and total injuries.]

Tvaryanas (2003)
Wind shear in the North Atlantic flight corridor at FL350

Slope \((m \, s^{-1} \, hPa^{-1}/\text{decade}) = 0.008\) p-value = \(< 0.001\)

Slope \((m \, s^{-1} \, hPa^{-1}/\text{decade}) = 0.009\) p-value = \(< 0.001\)

Lee, Williams, and Frame (forthcoming)
Number of clear-air turbulence models projecting an increase in the North Atlantic from climate change
“Slight strain against seat belts; unsecured objects may be displaced slightly; food service may be conducted with little difficulty walking”

“Definite strain against seat belts; unsecured objects are dislodged; food service and walking are difficult”

“Occupants are forced violently against seat belts; unsecured objects are tossed about; food service and walking are impossible”
Projected change in amount of clear-air turbulence globally by 2050–2080

Storer, Williams & Joshi (2017)
Air turbulence tests 'improved'

A more accurate way of predicting air turbulence for aeroplanes has been developed by researchers.

Dr Paul Williams, from the University of Reading, was part of a global team of academics who have developed a new forecasting technique.

Dr Williams said clear-air turbulence can strike suddenly, causing damage to planes and injury to passengers.

BBC Berkshire
Sport, travel, weather, things to do, features and much more

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- Man robbed and attacked by group

http://news.bbc.co.uk/1/hi/england/berkshire/7654768.stm
The Increasing Threat of Turbulence
Katya Vashchankova
Head MET Program,
IATA
Turbulence Data Sharing Project

Katya Vashchankova
Head, IATA Met Program
Eddy Dissipation Rate (EDR)

ICAO Annex 3 metric for turbulence
Measuring the state of the atmosphere around the aircraft in flight
Aircraft independent absolute value
Simple software installation, no hardware required to calculate EDR
Avionics Bus

TAS: 447kn
AoA: 4.6°
EDR .34

Avionics Bus

TAS: 447kn
AoA: 3.9°
How can your airline implement EDR reporting capability?

- OEM/Avionics solution providers (e.g. customization of existing ACMS/AHM)
- EFB application via AID
- Onboard wi-fi server
- IATA Turbulence Reporting Guidelines
Airlines requested IATA to be a global data consolidator

- Existing turbulence data is often not shared
- Fragmented data pools limit benefits
- Airlines need to see beyond their own data to mitigate turbulence
- Importance of global data coverage
IATA Turbulence Aware

A global platform for sharing automated EDR turbulence reports in real-time

- Data is collected from airlines, business aviation or third party ground servers in real-time
- Data is consolidated, quality controlled and de-identified
- Data processing through the platform is max 30 sec
- Airlines can use their own flight planning and in-flight tools to display the data, or use IATA Turbulence Aware viewer in-flight via Wi-Fi
Current Turbulence Aware Viewer Features
Current Turbulence Aware Viewer Features
Benefits of data driven turbulence mitigation

- Improved safety outcomes
- Efficient fuel planning and reduced discretionary uplift
- Inflight flight level optimization
- Saving on engineering inspection requirements
- Enhanced customer experience and brand image
Highly collaborative development with airlines
Platform Implementation Timeframe

Feb 2019 - Dec 2019: Operational trials available to Airlines for evaluation and feedback

Jan 2020: Full launch
Any questions on how to adopt a turbulence data reporting capability or obtain access to IATA’s Turbulence Aware Data platform, please contact:

iataturbulence@iata.org

www.iata.org
The Increasing Threat of Turbulence

Richard Niland
Senior Flight Operations Engineer & EFB Administrator,
Aer Lingus
IATA Turbulence Aware
- An EFB Approach

Richard Niland
Senior Flight Operations Engineer / EFB Administrator
Aer Lingus Fleet

- A320 x 34
- A321 x 3
- A330-200 x 5
- A330-300 x 8
IATA Turbulence Aware

- Improve Safety
  - Minimise encounters
  - Minimise effect of encounters
    - Cabin crew injuries
- Improve Passenger Comfort
Participation Strategy

- Compute
- Communicate
- Use

**Traditional Approach**
- Avionics
- ACARS
- ?

**EFB Based Approach**
- EFB Device
- Wi-Fi
- EFB Device
System Overview

ARINC / SITA Type B

Airline Ops Centres

Read → Normalise → Validate → Store → Anonymise → Write

Airline / Authorised Agent System

Met Viewer
System Overview

- ARINC / SITA Type B
- Airline Ops Centres
- IATA Data Repository
- Met Viewer

Airline / Authorised Agent System
Aer Lingus EFB system

- Surface Pro devices
  - Aircraft attached
  - Power and data connection
  - navAero hardware

- Primary Applications
  - Flight log
  - Performance
  - A/C Library
  - Charting
    - Airport Moving Map

- Wi-Fi Connection
  - Dedicated network
  - Isolated from passenger use
Aircraft Interface Device

- Mounted in Avionics bay
- Data Connections
  - Navigation data
  - Position, speed & orientation data
  - Aircraft & sector information
  - Discretes
EDR Calculation

- Mechanism
  - 6 inputs
    - Speed
    - Angle of Attack
    - Pitch
    - Pitch Rate
    - Roll
    - Vertical Velocity
  - 8 times per second
  - Single EDR result per minute
EDR Calculation

- Open Source Software
  - National Centre Atmospheric Research (NCAR)
  - Smooth conditions
    - Reports ‘heartbeat’
  - Turbulence encounter
    - Reports series of data points
- Aer Lingus ‘in-house’ host software
  - No crew interaction
  - Automatic
    - Provides data to calculation engine
    - Transmits outputs to IATA repository
Turbulence Reports Display
Turbulence Reports Display
Turbulence Reports Display
Why use this approach?

• Cost Effective
  • No budget
  • No avionics software updates required
  • All work in-house
  • Reduced data transmission costs
    • WiFi v ACARS
• Use of existing infrastructure
• Adaptable
  • All aspects easily customisable
Why use this approach?

• Airlines with a similar EFB system
  • May allow effective, low cost participation in IATA initiative
    • Commercial software solutions may become available
    • Leverage greater return on investment from existing system

• Airlines considering an AID based EFB
  • Additional functionality
  • Improved business case

• Join the IATA initiative!
Thank you
The Increasing Threat of Turbulence

Captain Rich Terry
Managing Director of Line Operations,
Delta Air Lines
Delta Air Lines

Mitigating the threat of turbulence
• Turbulence reporting today
• What is EDR? - Capturing the Atmospheric State
• First Evolution: objective turbulence reporting
• Second Evolution: turbulence forecasting
• Delta’s Flight Weather Viewer
• Realized benefits
• Vision for the future
Turbulence Reporting Today

An Antiquated Process

– PIREPs
– Turbulence Plots
– Informal reports: ATC “Chat Room”
– Subjectivity/Inaccuracy: time, space, severity
– Mitigating a risk that is not clearly defined
The Eddy Dissipation Rate (EDR) takes data from the aircraft to describe the underlying atmospheric state.

- Objective
- Normalized
- Usable

BUT… not all EDR metrics are equal.
## EDR MODELS

<table>
<thead>
<tr>
<th>Vertical Accelerometer (A/C)</th>
<th>TAS-based</th>
<th>Vertical Wind (NCAR EDR)</th>
<th>NCAR-derived (Proprietary)</th>
<th>iPad Accelerometer</th>
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<tbody>
<tr>
<td>Open-source</td>
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<td>Objective</td>
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<tr>
<td>Describes atmospheric state</td>
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<tr>
<td>Open to study, Correlation</td>
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Delta Air Lines Proprietary & Confidential
1ST Evolution – Turbulence Reporting

STRENGTH

- Objective
- Reliable – 4D
- Timely
- Usable across work groups

WEAKNESS

- Reactive
Combine EDR with Advanced Open Source Forecasting Models

- NCAR GTG -3
- NCAR GTG – NOWCAST (up to the minute updates)
- Radar
- Satellite
- Government provided weather models
Near-real-time “NowCast” from NCAR

Jet stream converges with Herman rotation

KSGF

KMEM
Delta’s FWV Harnesses Big Data

Harnessing Big data to tell a relevant story

• Our data=Open Source
• Gov’t MET products
• Quiet Dark Cockpit
  – Deliver threats
  – Standardized presentation
  – Alerting
Injuries avoided due to use of real-time turbulence data

- Captain chose to rely on turbulence data and secure the cabin despite a smooth ride report from ATC and PIREPs
- Aircraft subsequently flew through moderate turbulence
- Several unsecured items were tossed about. However no injuries to passengers or cabin crew occurred
Present State/Realized benefits

• Delta’s Current State
  – Threat Based Weather App launched in 2016
  – Flight Weather Viewer Plus – (Nowcast) in 2017
  – iPad development – Global product Launched June 5, 2018

• Realized benefits
  – Safety (Greater Awareness of upcoming threats)
  – Efficiency/Emissions
  – Passenger Experience (setting expectations)
  – Moderate/Severe encounter reduction (independent EDR study)
## Data Sharing Requirements

<table>
<thead>
<tr>
<th>Turbulence Reports (Micro)</th>
<th>Accessible/Usable by all?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-source turbulence reports</td>
<td>✓</td>
</tr>
<tr>
<td>Proprietary turbulence reports that have been openly correlated</td>
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<tr>
<td>Proprietary that cannot be correlated</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turbulence forecasting (Macro)</th>
<th>Accessible/Usable by all?</th>
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<tbody>
<tr>
<td>Aggregated, shared data -&gt; Open-source gov’t met product -&gt; Any Interface/Viewer</td>
<td>✓</td>
</tr>
<tr>
<td>Aggregated, shared data -&gt; proprietary products -&gt; pay for value added by our data</td>
<td>X</td>
</tr>
</tbody>
</table>

EVERYONE’S DATA, ACCESSIBLE AND USABLE BY ALL ON APPS THAT EACH USER CAN CHOOSE
Captain Rich Terry
Managing Director of Line Operations
Richard.L.Terry@Delta.com