Delta Air Lines -
Data Access Issues,
Human in the Loop &
Forecasting Challenges

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Theme
Teaming w/ Delta Pilots & Ops Center

Topics
• Current Turbc Obs & Data Access
• Current Human-in-the-Loop Process
• Future Plans: Forecasting & Display
How does Delta Air Lines produce Turbulence Reports?
Delta Turbulence Reporting

Manual Reporting via ACARS: Detailed Version

- Flt Progress → Turbulence → Intensity

→ Detail (Options)
Delta Turbulence Reporting

**Manual Reporting:** Text of Turbc Area Report

<table>
<thead>
<tr>
<th>REPORTED TURB LEVEL: SMOOTH.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM FL: 360 TO ---</td>
</tr>
<tr>
<td>FROM FIX: DENDU TO FIX: 50N040W.</td>
</tr>
<tr>
<td>FROM ABEAM: / TO ABEAM: /</td>
</tr>
<tr>
<td>SMOOTH FLIGHT LEVEL: 360.</td>
</tr>
<tr>
<td>PILOT REMARKS: A/C ABOVE OUR FL REPORT LGT/MDT TURB</td>
</tr>
</tbody>
</table>

**Automated Reporting:** g-Load


**Automated Reporting:** EDR Text

N33829W11874306560986P0952140120XXXX25::30NXW
N33755W11872206571300P0422240250XXXX25::30W/X
N33721W11861306581482P0022310440XXXX25001Y20)

- The last 5 chars are EDR info & base64 encoded.
- Delta has no internal method to decode & read the info.
Used by Delta OCC in the past
EDR Turbulence Viewer 1.15

Included Display of:
- Delta’s EDR Reports (color coded dots)
  &
- GTG Forecasts (color coded areas)

Currently Working w/ Delta IT to be able to Access:
- Viewer 2.2.9
Looking to be able to once again access historical Delta a/c EDR reports & display.
Delta Appreciates All the Efforts by NCAR & FAA over the years to provide display capability of EDR.

Delta’s now focusing on capability to display both:
- EDR Reports &
- GTG Forecasts

On Delta tools
How does Delta Air Lines prepare for En Route Turbulence & other Weather Hazards?
Delta has products & processes in place for these en route weather hazards:

- Turbulence
- Mountain Waves
- Thunderstorms
- Ozone
- Volcanic Ash
- Space Weather
En Route Hazards – Depictions

The Upper Air Depiction is a strategic flight planning tool that is issued before the first flight in the bank departs. They are created for anywhere Delta flies.
En Route Hazards – TP’s

Turbulence Plots (TPs) are tactical flight planning/flight following tool that are issued and updated as conditions warrant and contain most current info.
TP’s Benefits

• Consistent product no matter where in the world
• All hazards
• Delta size aircraft
• Updated as needed
TP Types and Hazard Intensity

AVOID
- Severe Icing
- Strong Mtn Wave
- Mod-Sev, Severe Turbc & Volc Ash Cloud > FL250*

ALERT
- Moderate Icing
- Moderate Mountain Wave
- Moderate Turbulence
- Thunderstorms, Ozone, Space Weather, Volcanic Ash*

ADVISORY
- Light-Moderate Turbulence
- Frontal Windshear
Avoidance Policy and Procedures

**AVOID**
Avoid SEVERE OR STRONG ALTITUDES (unless under emergency authority)

**ALERT**
Recommend Avoidance if feasible. Minimize exposure to the affected altitudes or areas.

**ADVISORY**
No Restrictions
What tools do Delta Meteorologist use to create these manual and human-in-the-loop products?
Meteorology Tools – Looper

Meteorologists can choose model type, time, and parameters to view and animate.
Upper Air Depictions manually drawn in VectorWorks, CAD software heavily modified by Delta Technology for Wx Charts.
Meteorology Tools – Turbulence Management System

Plots PIREPS

Overlay Current Model Data

Click TP lat/lon points
Meteorology Tools – WxStream

Template for all our products: Import TP lat/lon from TMS.
How do weather products get distributed at Delta?
The Dispatcher and Pilot-in-Command are jointly responsible for the preflight planning, delay and dispatch release of a flight in compliance with Part 121 and the Operations Specifications.

The Dispatcher is responsible for:

• Monitoring the progress of each flight.
• Issuing necessary information for the safety of the flight.
• Canceling or re-dispatching a flight if, in their opinion or the opinion of the pilot-in-command, the flight cannot operate or continue to operate safely as planned or released.
Upper Air Depictions can be an overlay on Graphical Flight Planning tool
As soon as TP’s are issued, they are sent to the applicable dispatcher queue and displayed on GFF.
PIREP Distribution to Dispatchers
Product Distribution to Pilots - Preflight

TP’s are also included in every flights pre-flight paperwork

TPS-ENROUTE

NE13  271355–271755
TP NE13  271355Z
1.OH PA WV
2.* ADVISORY *
VOR:HVQ EWC
HAZ:TURBC–OTHER
SOURCE:PIREPS
LINE:39N082W 41N080W
WIDTH:125NM
TIME:POSN AT 27/1353Z
ALTS:FL320–380 LGT/MOD
MVG FROM:STNRY
INFO:AREA OF
CONVERGENCE
3.VALID 271355Z/271755Z
4.CANCEL NONE
When a TP issued/updated and is along the route of a flight in progress, the dispatcher manually sends and adjust plan if needed.

Pilots also have the ability to request TPs thru ACARS.
What’s Next?
Integrating Human & Model Forecast

Take advantage of advances in technology to move Delta into a real-time graphical world.
- Tablets in the cockpit
- Model based forecast

Step 1: Provide access to current products on tablet
Step 2: Enhance Products & integrate global data into dynamic display
Step 3: Transition Meteorology to over-the-loop instead of manual & in-the-loop forecast and provide flight specific graphics
Step 1: Provide Access to current products with prototype app

GTG Forecast available on the AWC website
Step 1: Provide Access to current products with prototype app

Delta Meteorology TPs (graphic & text) with radar overlay
Build a system that can integrate global data:

- Model data, including GTG
- TP’s & Depictions
- Turbulence Reports, including traditional and auto-generated
- Satellite
- Lightning
- Radar
- SIGMETS
- Volcanic Ash Advisory

Develop tools for pilots, dispatchers & meteorologist using same data for common operation picture.
Aviation Wx Center
Display Capability Excellent & Detailed Info

- Detailed & consistent information over US
- Dynamic display with overlay options
Aviation Wx Center
Global Products lack Consistency

- Global Products lack detail and consistency
- Can not integrate Delta Meteorology Forecast
Step 2: Enhance Products & Integrate Data: All Hazards for a Global Operation

Overlay Options:
- TP’s
- Thunderstorms
- Ozone
- Space Wx
- Satellite – IR
- Satellite - Visible
- Turbulence
- Winds
- Volcanic Ash

Overlay Options on Pilots Tool are viewable in Dispatch Flight Following Tools
Step 3: Transition Meteorology to Human Over The Loop as Models Improve

Delta Meteorologist thinks there is potential severe turbulence and can increase intensity.
Step 3: Flight Specific Graphics

Pilot can enter the flight number and see path along with all hazards in horizontal and vertical views.

Dispatcher can see the same in their view.

Overlay Options:
- TP's
- Thunderstorms
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Turbulence Forecast Challenges
• Rapidly Changing Conditions and changing plans
  – Current: TP are pushed for notification
  – Future: Alert based on exceeding thresholds along the flight route
• Meteorologists editing 4-d gridded parameters on a global scale
• Meteorologists keeping situational awareness--Understanding why there is turbulence
Turbulence Forecasting Challenges

- Able to locate large area favorable for turbulence
- Difficult to resolve detail:
  - exact location, timing & intensity
- Need forecast model improvements
- Applying gridded based values to impact on different size aircraft
Managing data displays to highlight significant operational impacts
Delta would like to team with other org’s to:

– Compare current turbulence forecast methods:
  - Models (GTG & others)
  - Manual Forecasts

– Evolution of integrating model(s) & human input:
  - Human-in-the-Loop
  - Human-over-the-Loop &
  - Eventual exclusive use of models for turbulence forecasting
• **Observations**
  – AOC’s as well as Pilots need EDR Access
  – We need a balance between simple & complicated
  – Both g-load & EDR info are useful.

• **Evolution of Turbulence Forecasting**
  – Delta’s goal: Transition to Reliance on Models and Human-Over-the-Loop
  – Similar Evolution path as wind forecasts
    » From manual to completely automated

• **Create common operating picture between AOC’s and pilots for all hazards on global scale**

• **In 2040 will Turbulence be an issue?**