

Progress in Turbulence Information – Product Research and Development

Presentation at the NBAA/FPAW Forum

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In situ Turbulence Measurement and Reporting System



Goal:

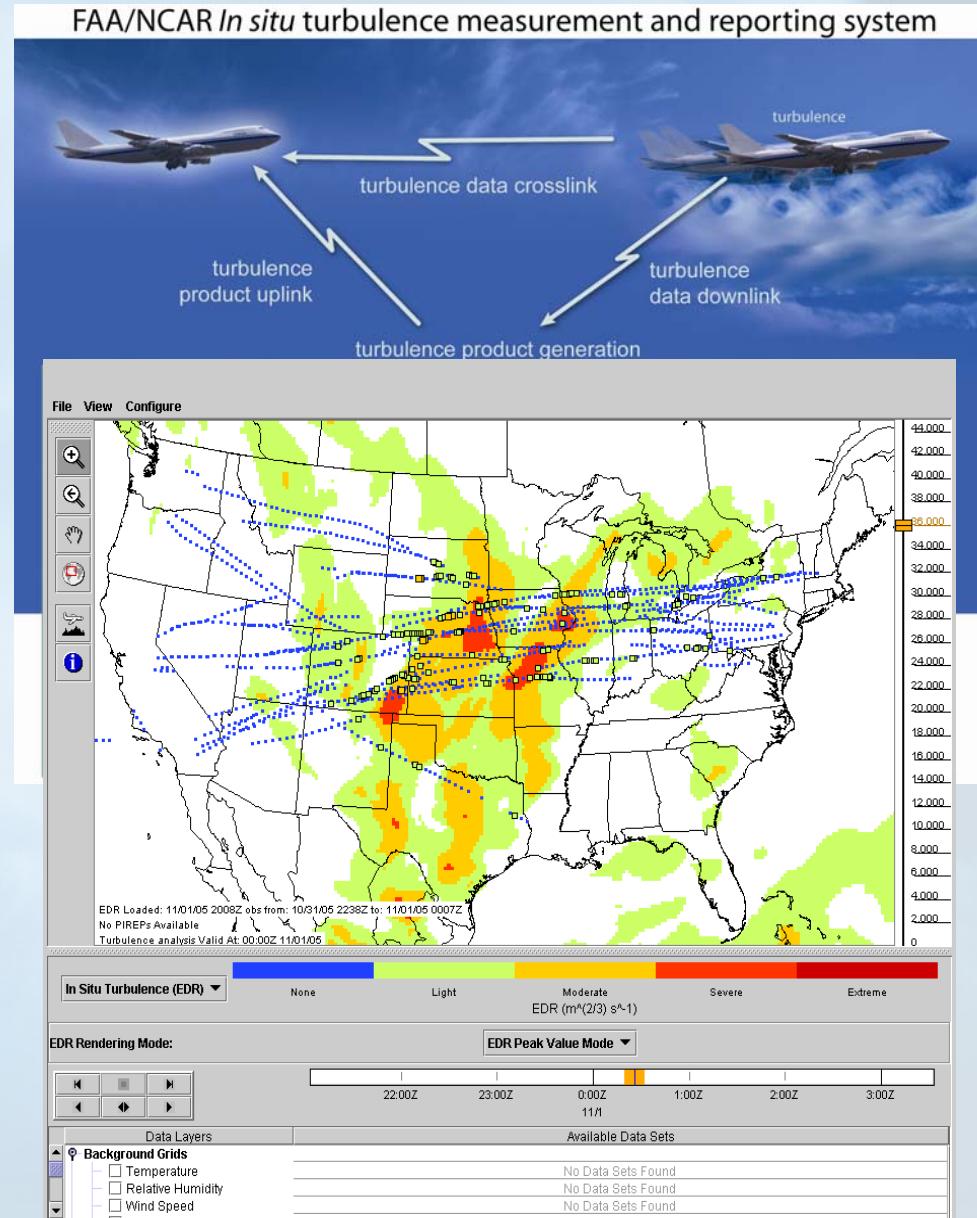
- Augment/replace subjective PIREPs with objective and precise turbulence measurements.

Features:

- Atmospheric turbulence metric: eddy dissipation rate (EDR).
- EDR can be scaled into aircraft turbulence response metric (RMS-g).
- Adopted as ICAO Standard

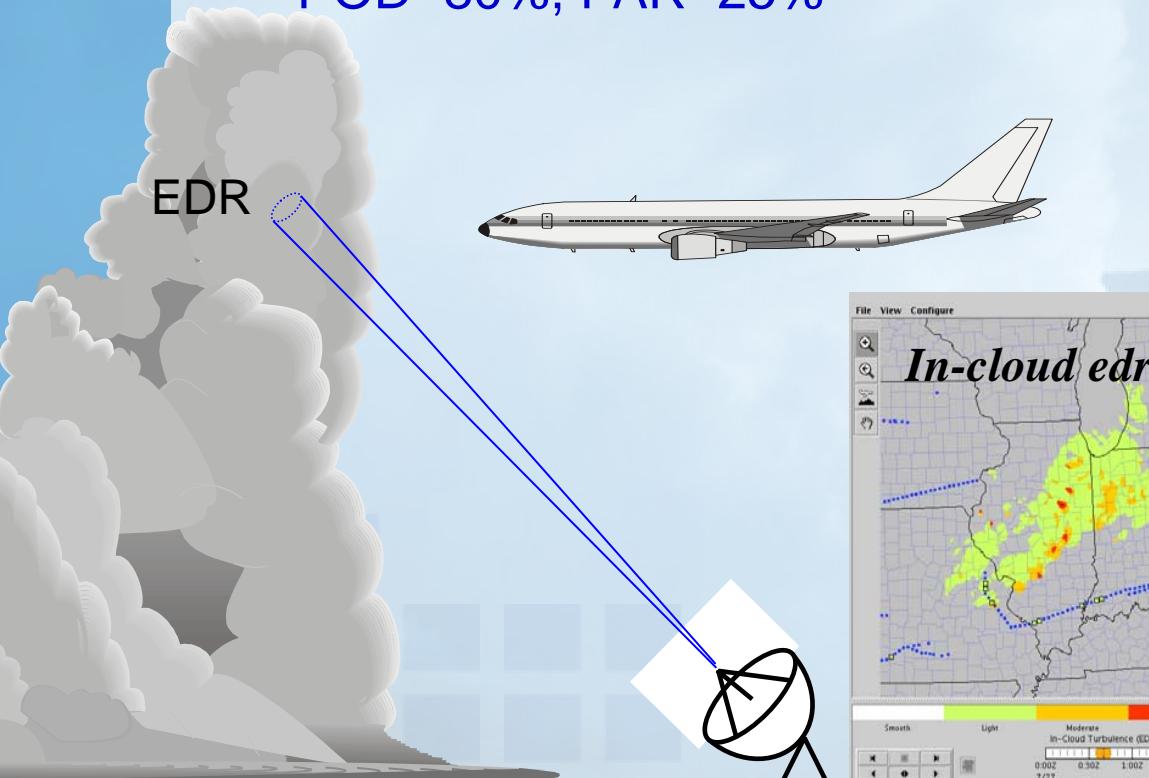
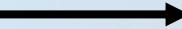
Status:

- ~ 200 UAL aircraft now
- Begin SWA fleet-wide implementation by June 2007, completed by end of 2007 (~400)
- Delta, NWA ?



NEXRAD in-cloud turbulence detection algorithm (NTDA)

- Ground-based displays
- Cockpit displays from uplinks
- Scheduled for ORPG Build 10 NEXRAD update (operational 2009)
- POD~80%, FAR~25%



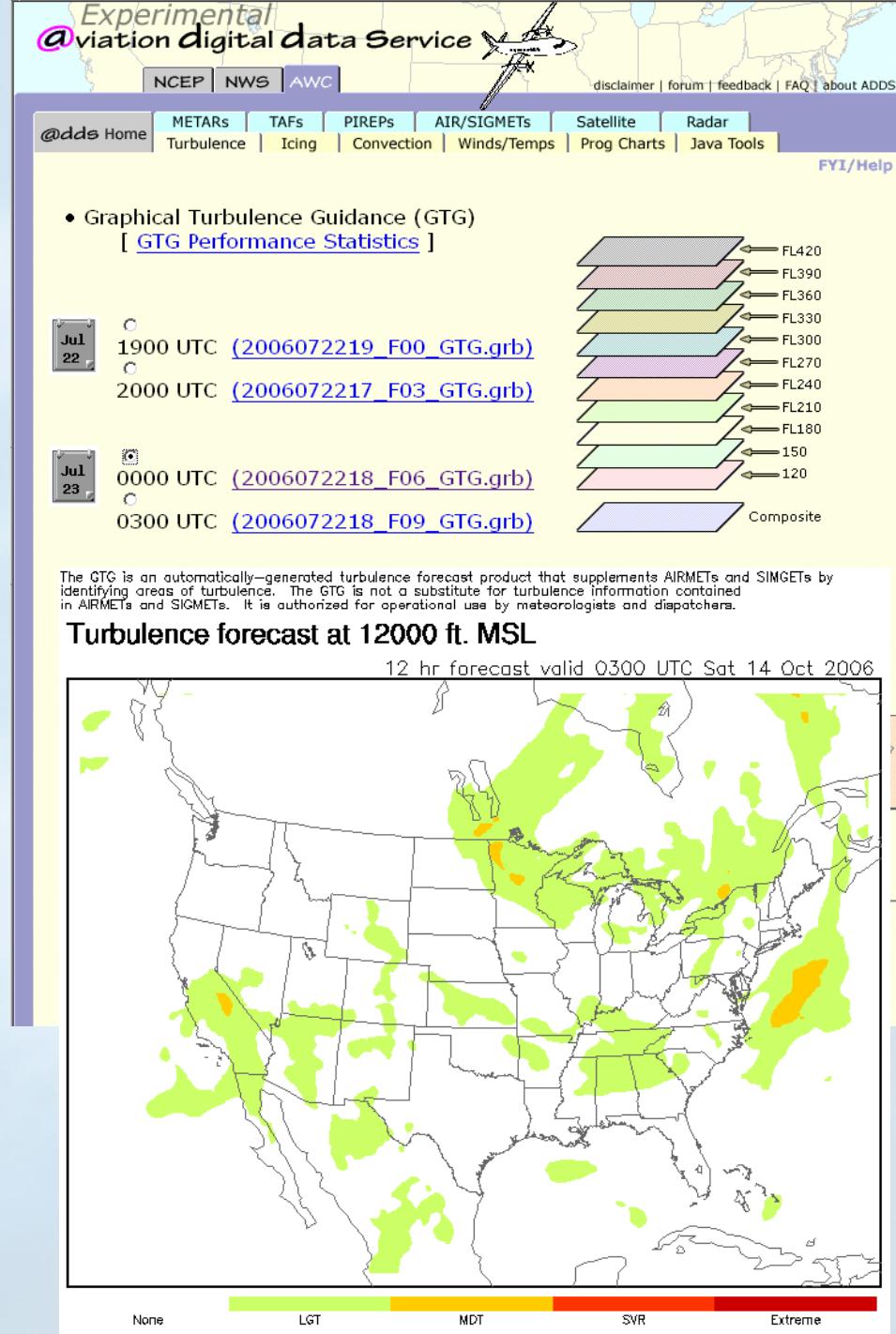
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EXP TURB FI UAL[REDACTED]
-- 20 Oct 2005 22:08:57Z
PL 360 orient. 95 deg
'X'=aircraft, '+'=waypoint, '*'=route
'='no_data, 'o'=smooth, 'l'=light
'M'=mod, 'S'=severe
----- (36nm to COWES) -----
1111 1*MMMMMM11
112nm 111 11*11MM1111
11M*MM1111111
108nm 11M*MM1111111
11M*MM1111111
104nm 1MM*1111
11*1
100nm 11
11 11 111111111111
096nm 1111111111111111
1111111111111111
092nm 1111111111111111 1
1111111111111111
088nm 111111MM111111
111MM111111111111
084nm 1111111111111111
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080nm 1111111111111111
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111 11111111111111
012nm 11 11 111111111111
008nm *
004nm *
valid -----X-----
2205Z -40nm (39.0N, 92.1W) +40nm

```

Turbulence forecasts – GTG2

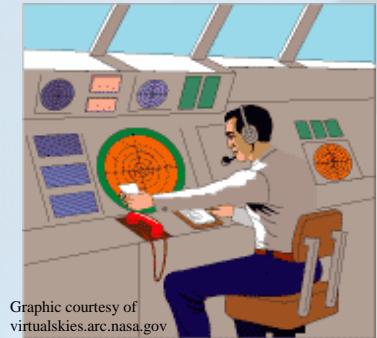
- Extends GTG1 to 10,000 ft MSL
- Improved accuracy at upper levels
- Uses UAL in situ data
- Status
 - D4 scheduled for 16 Nov 2006
 - Operational on ADDS early 2007



GTG-N

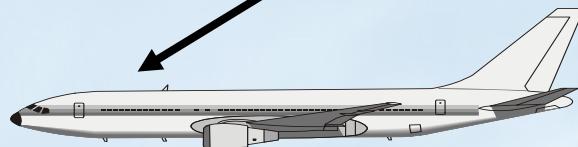


- Tactical avoidance tool
- Merges all current turbulence observations
- Updates every ~ 15 min
- D3 expected 11/08

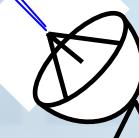


Cockpit display or alert

ADDS: Dispatch, ATC, etc.



*In-situ reports,
PIREPs,
MDCRS winds
and temperatures*

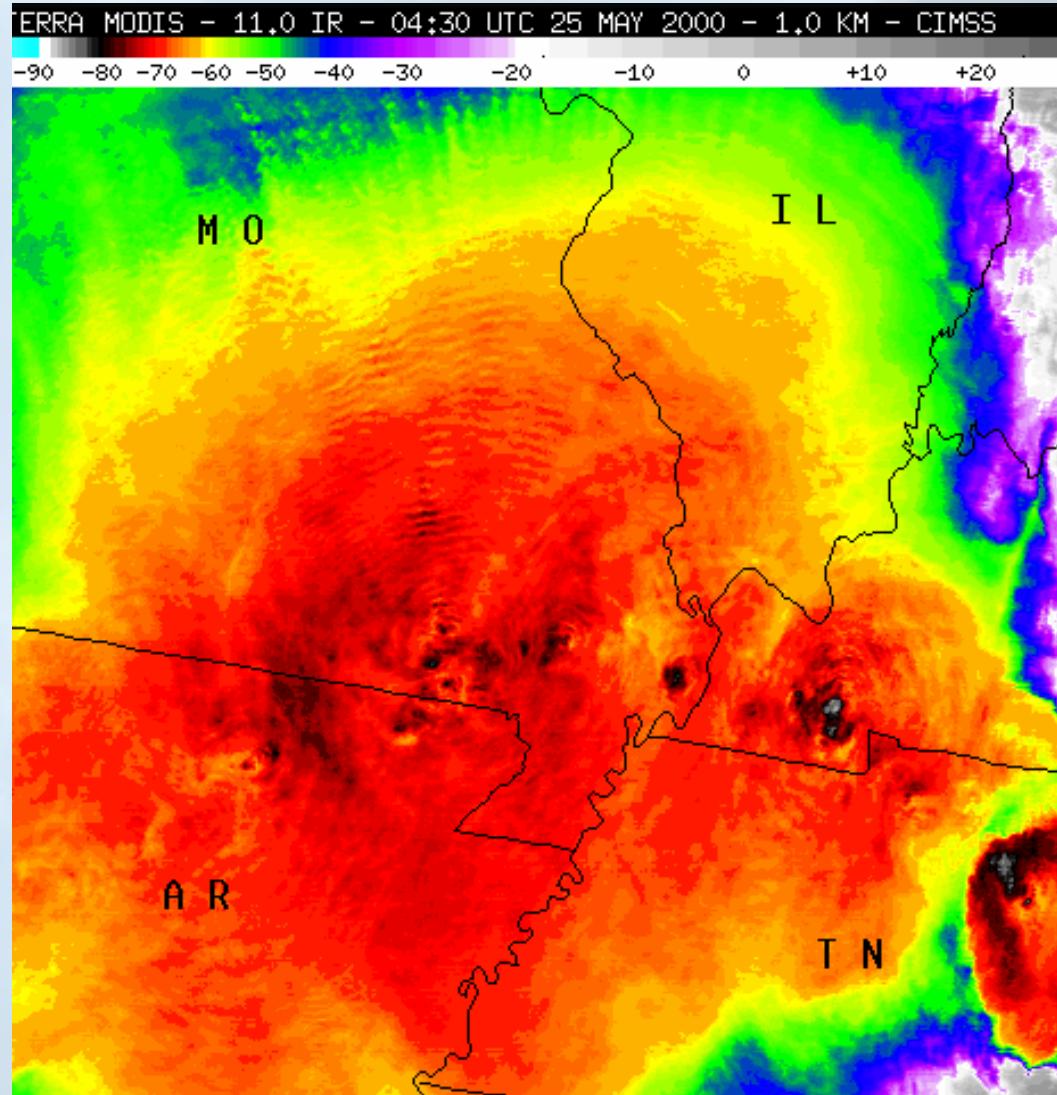
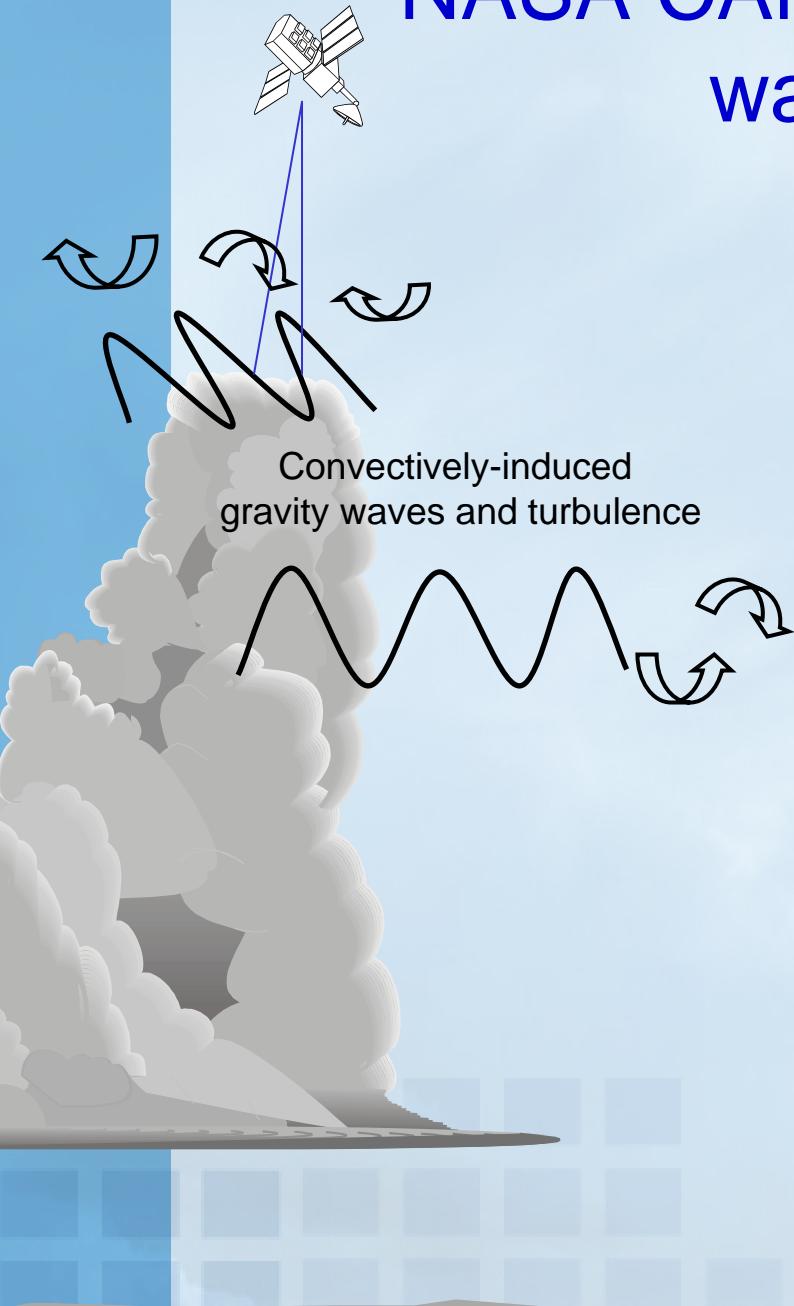


NTDA grids



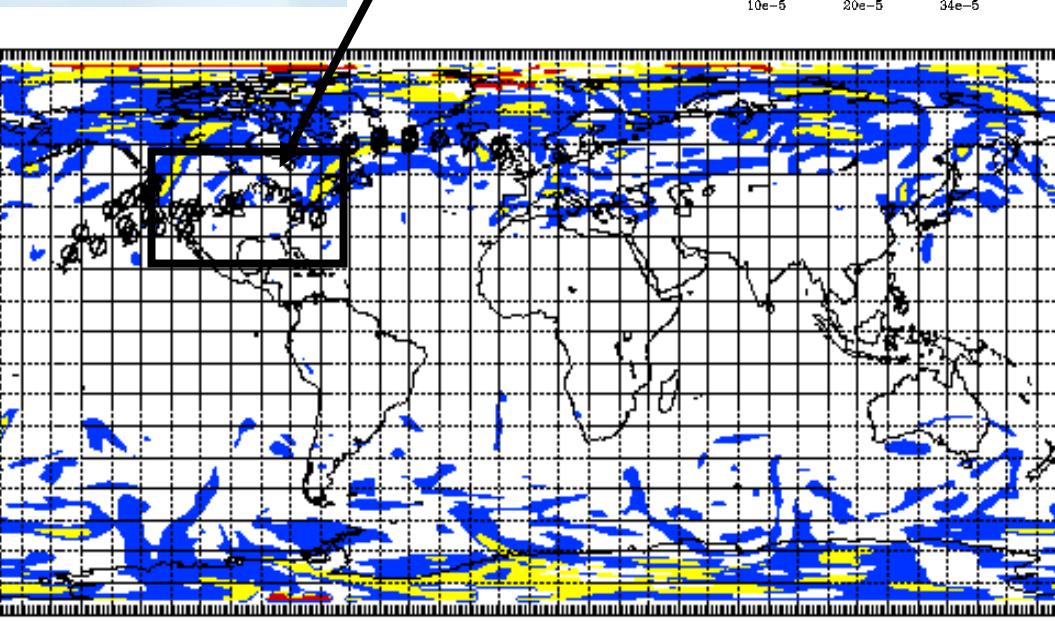
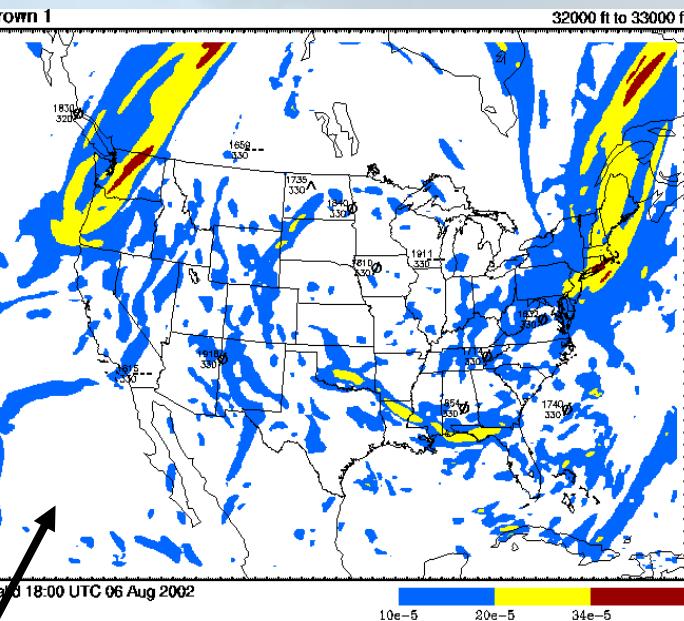
*GTG grids
CIT diagnostics
Satellite data
Conv. Wx nowcasts*

NASA CAN: Relate CIT to gravity waves -> GTG-N



Global GTG

- Uses NOAA's GFS model
 - Diagnoses and forecasts of CAT > FL200
 - Status
 - D3 was expected in 11/07
 - Operational early 2010
 - Delayed or cancelled



Example: Brown's index at FL320 06 Aug
2002 18Z Upper: RUC20 Lower: GFS

Cloud Top Height Product

- Aircraft-relative display of cloud top height based on satellite IR temperature mapped to pressure level w/ global numerical model
- Pacific, N. Pacific, and Gulf of Mexico
- UAL uplink to cockpit testing on US-Australia flights
- Status: D3 6/20/05, D4 delayed or cancelled

ADDS - Satellite - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://weather.aero/satellite/index.php

WebMail Contact People Yellow Pages Download Find Sites

Experimental aviation digital data Service

NCEP NWS AWC disclaimer forum feedback about ADDS

ADDSS Home Turbulence Icing Convection Winds/Temps Prog Charts Java Tools

METARS TAFs PIREPs AIR/SIGMETs Satellite Radar

Latest satellite imagery from GOES-8 and GOES-10:

Visible Infrared (Color) Infrared (B/W) Water Vapor

Western U.S. or Eastern U.S. image with overlay of IFR, MVFR, and VFR icons.

Experimental Cloud Top Height Product:

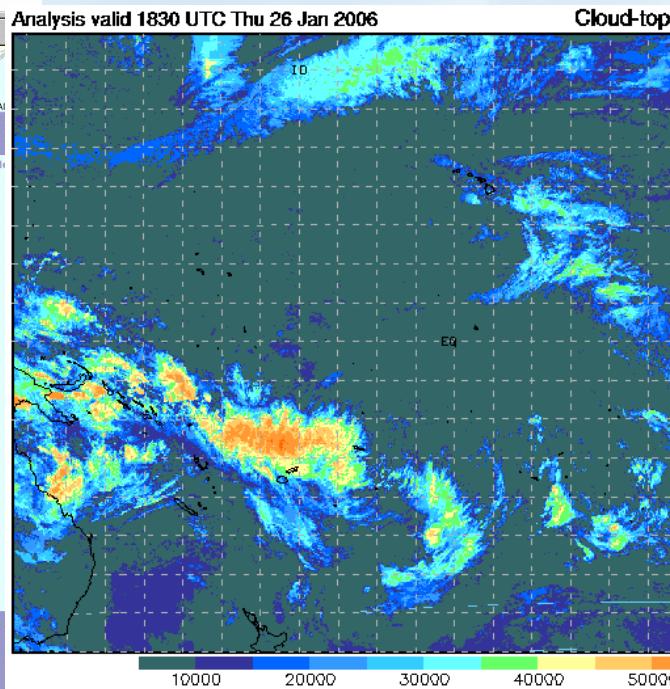
Gulf of Mexico Pacific North Pacific

International imagery on ICAO projections

Turbulence Icing Convection Winds/Temps Prog Charts Java Tools

METARS TAFs PIREPs AIR/SIGMETs Satellite Radar

Page loaded: 23:39 UTC
03:39 PM Pacific | 04:39 PM Mountain | 05:39 PM Central | 06:39 PM Eastern



/EXP CLOUD TOP FI UA839/AN N196UA 19 Jul 06
-- // Cloud tops 30,000 to 40,000 ft
-- 'C' Cloud tops above 40,000 ft
* 0.0N,168.0W

ASCII display via thermal printer

>40kft

30-39kft

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Projected GTG releases – next 7 years



| Version | Capabilities | D3 | D4 | Op |
|---------|---|-------|-------|------|
| GTG1 | Upper levels RUC20 | --- | 3/03 | 3/03 |
| GTG2 | Improved GTG1 Mid levels RUC13 Text generation Uses in situ | 11/04 | 11/06 | 2/07 |
| GTG3 | Improved GTG2 MWT 10 km RR WRF Probabilistic forecasts | 11/07 | 11/08 | 2/09 |
| GTG/TFO | Global - GFS | 11/07 | 11/09 | 2/10 |
| GTG4 | Improved GTG3 out-of-cloud turb forecasts | 11/08 | 11/09 | 2/10 |
| GTGN | Rapid upates in-cloud turb nowcasts in situ GTG4 0-2 hr analyses | 11/08 | 11/09 | 2/10 |
| GTG5 | Improved GTG4 Low levels | 11/09 | 11/10 | 2/11 |

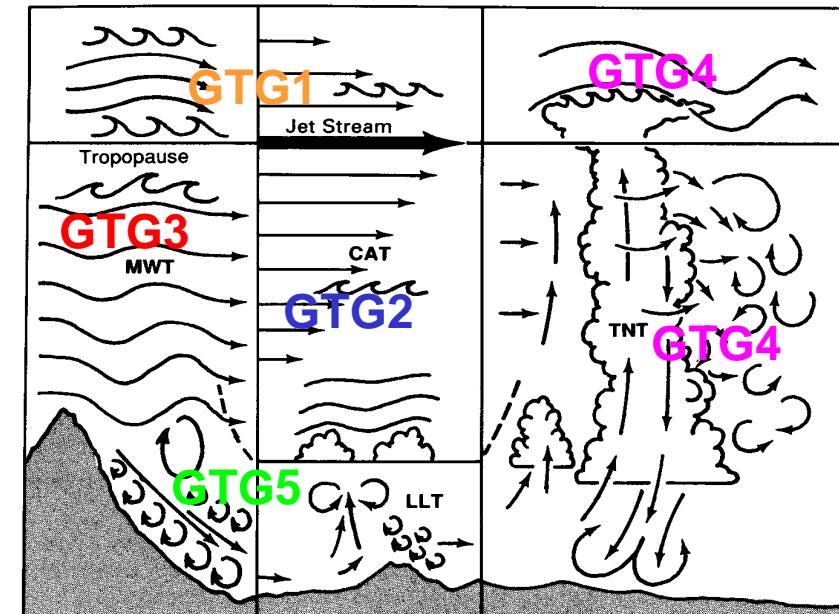


Figure 1-16. Aviation turbulence classifications. This figure is a pictorial summary of the turbulence-producing phenomena that may occur in each turbulence classification.

Source: P. Lester, "Turbulence – A new perspective for pilots," Jeppesen, 1994