Progress in Turbulence Information – Product Research and Development

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In situ Turbulence Measurement and Reporting System

NCAR

Goal:

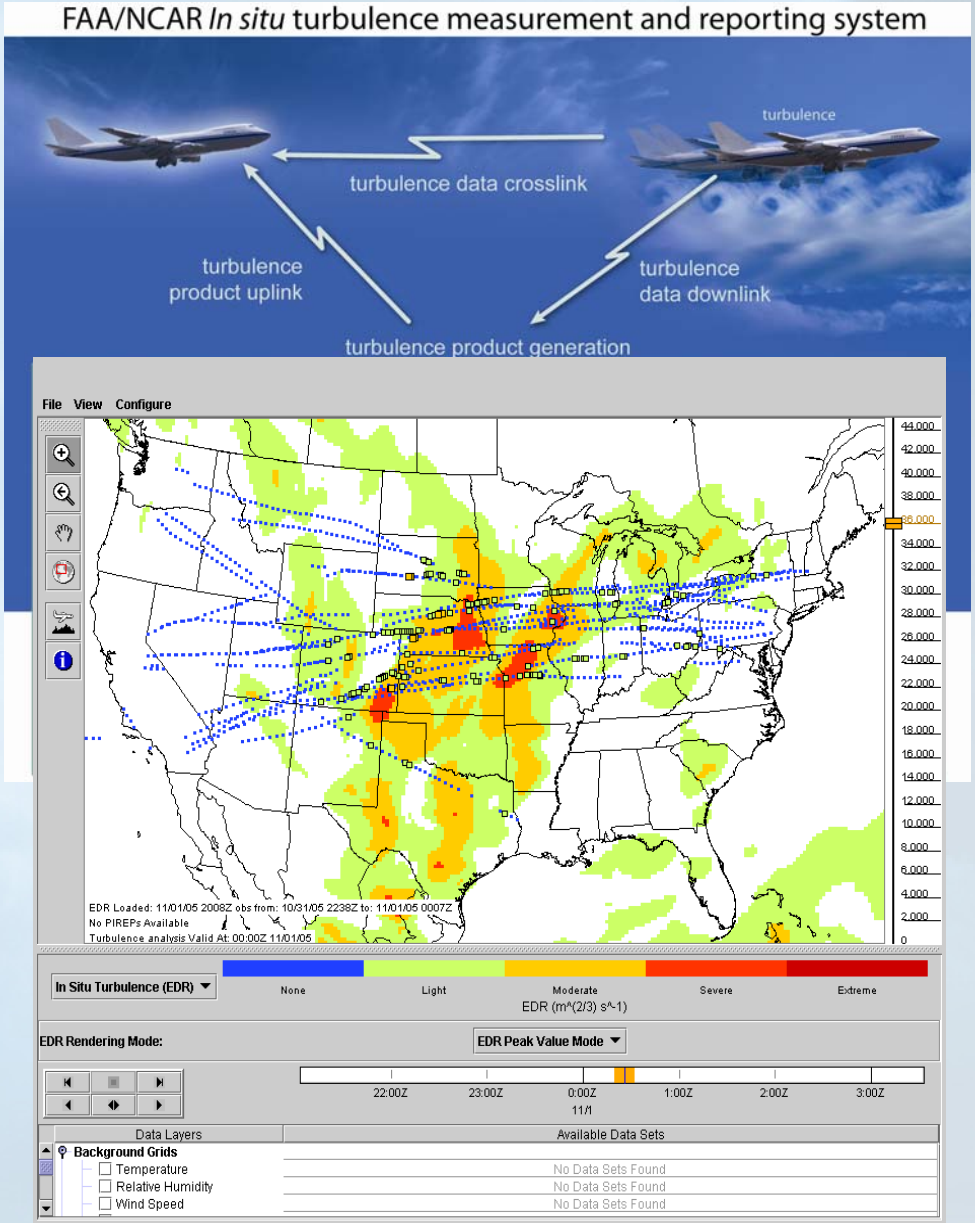
- Augment/replace subjective PIREPs with objective and precise turbulence measurements.

Features:

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

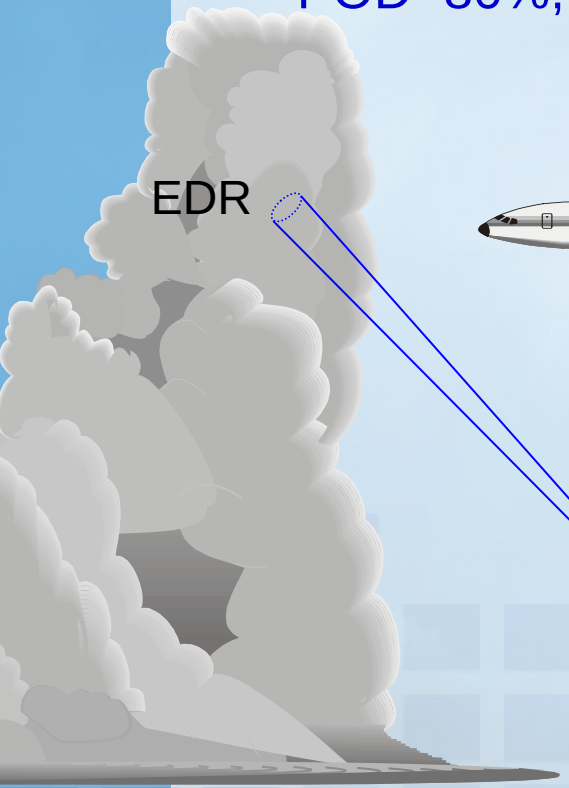
Status:

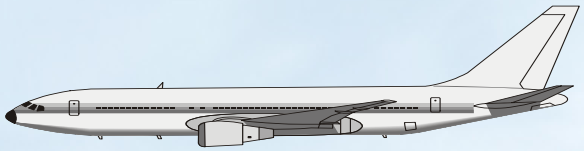
- ~ 200 UAL aircraft now
- Begin SWA fleet-wide implementation by June 2007, completed by end of 2007 (~400)
- Delta, NWA ?

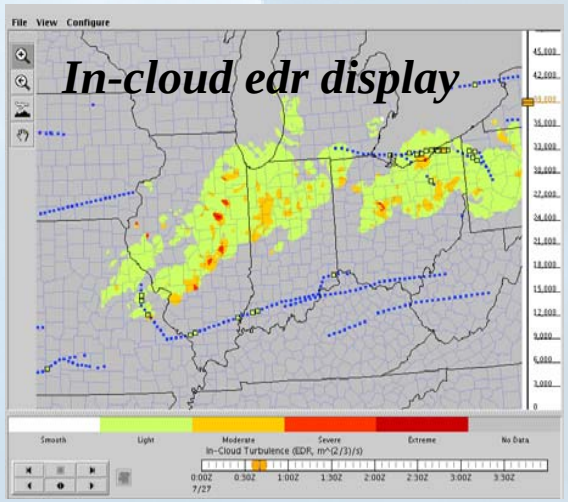


NEXRAD in-cloud turbulence detection algorithm (NTDA)

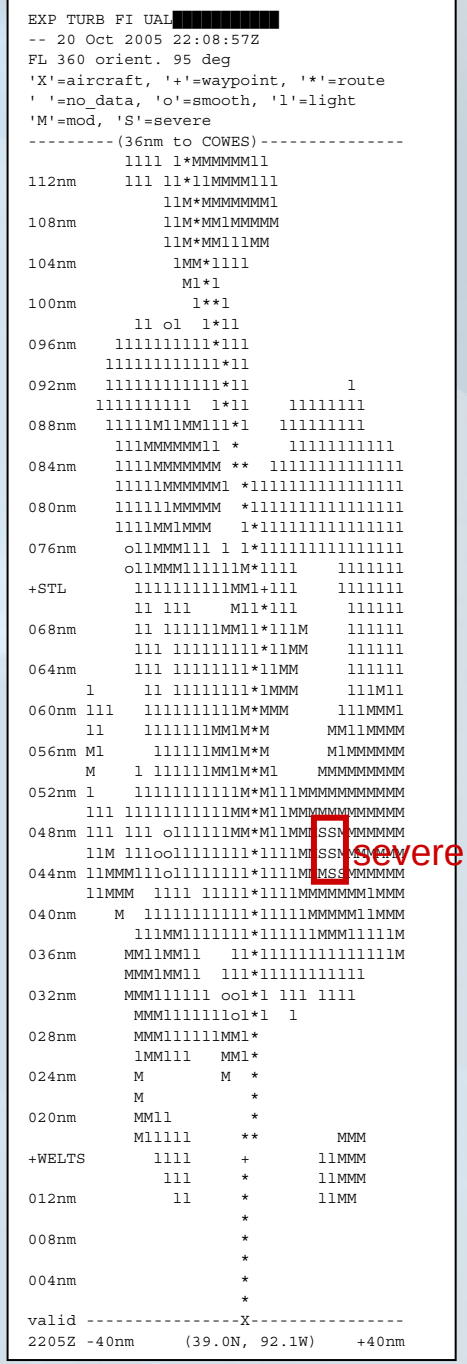
- Ground-based displays
- Cockpit displays from uplinks
- Scheduled for ORPG Build 10 NEXRAD update (operational 2009)
- POD~80%, FAR~25%







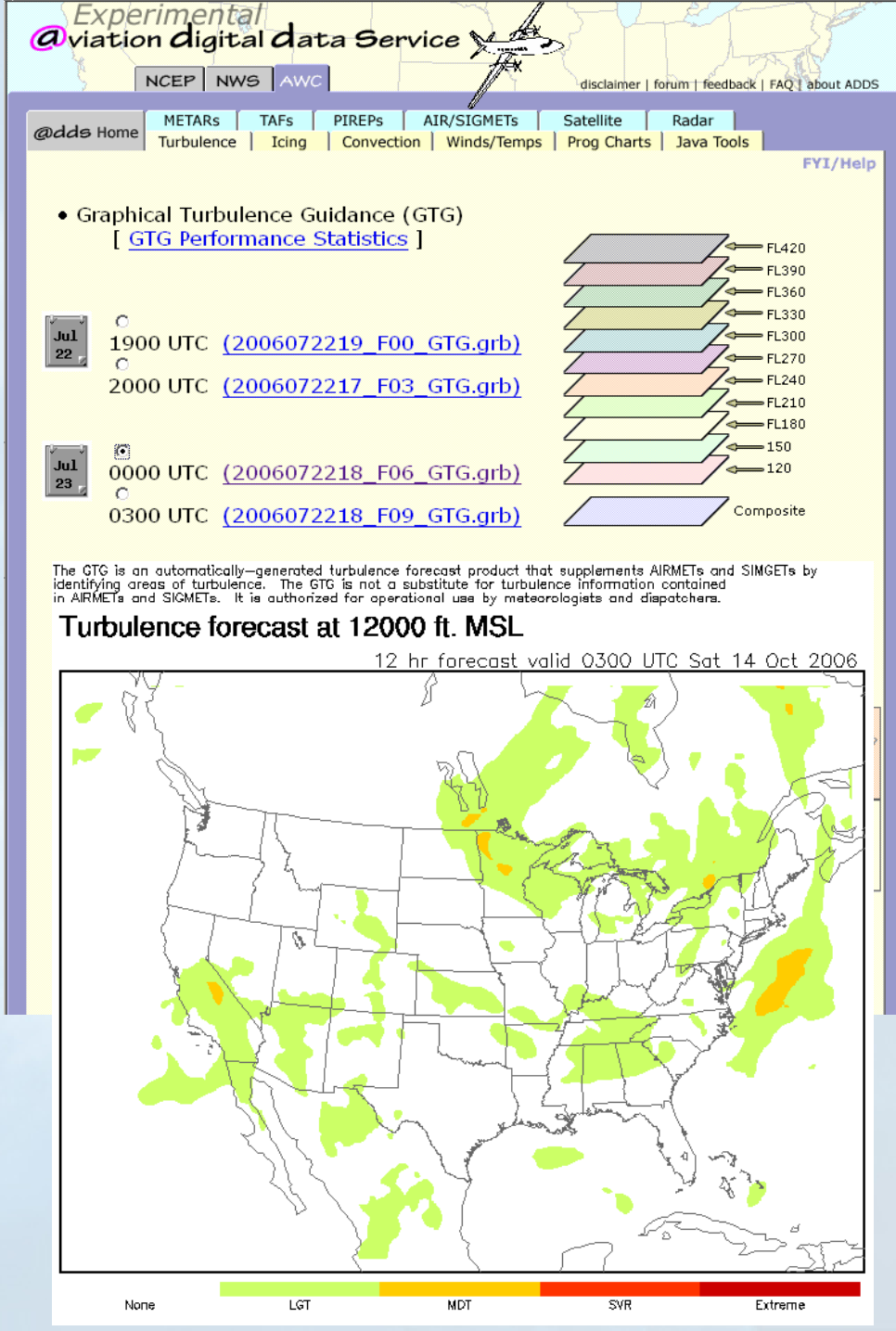
NEXRAD or TDWR



severe

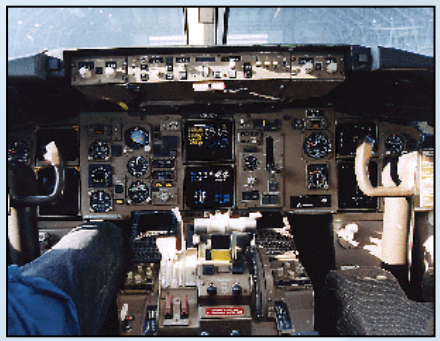
Turbulence forecasts – GTG2

- 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

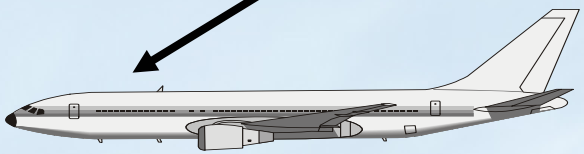
- Tactical avoidance tool
- Merges all current turbulence observations
- Updates every ~ 15 min
- D3 expected 11/08



Graphic courtesy of virtualskies.arc.nasa.gov

Cockpit display or alert

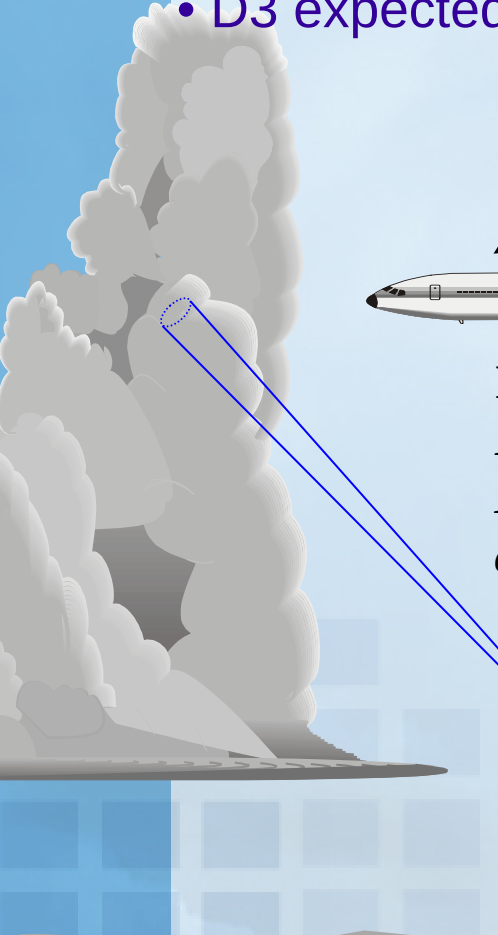
ADDS: Dispatch, ATC, etc.



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

GTG-N

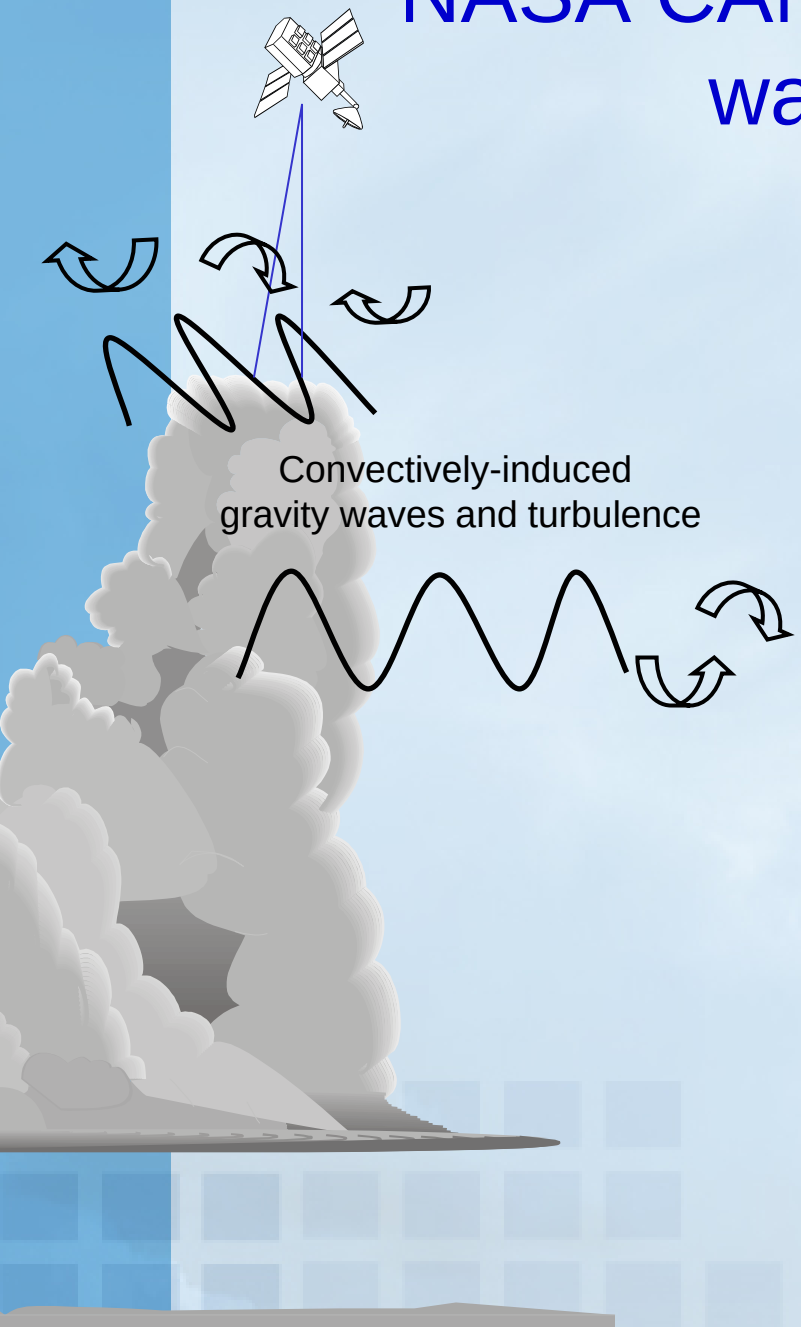
GTG grids
CIT diagnostics
Satellite data
Conv. Wx nowcasts

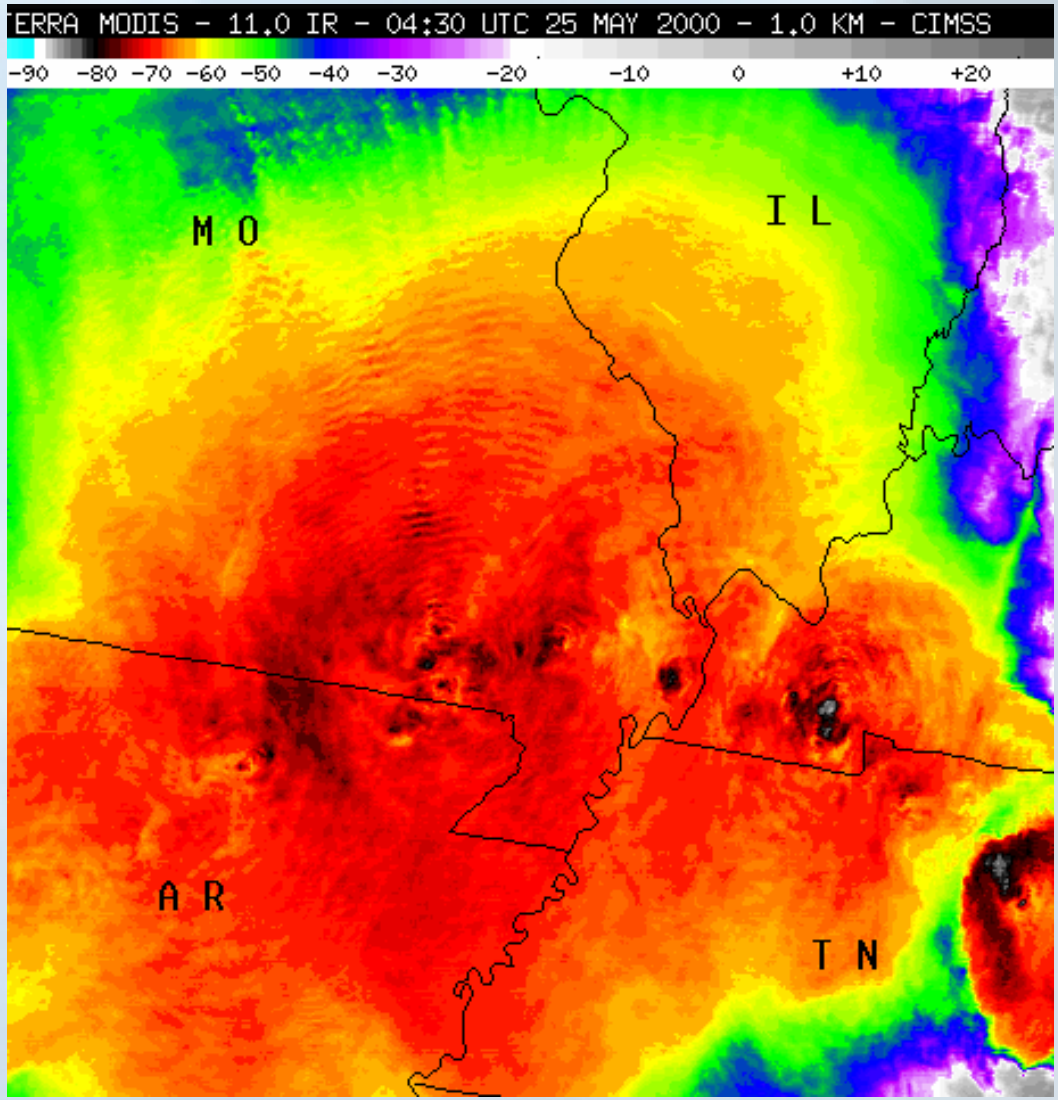


NTDA grids

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

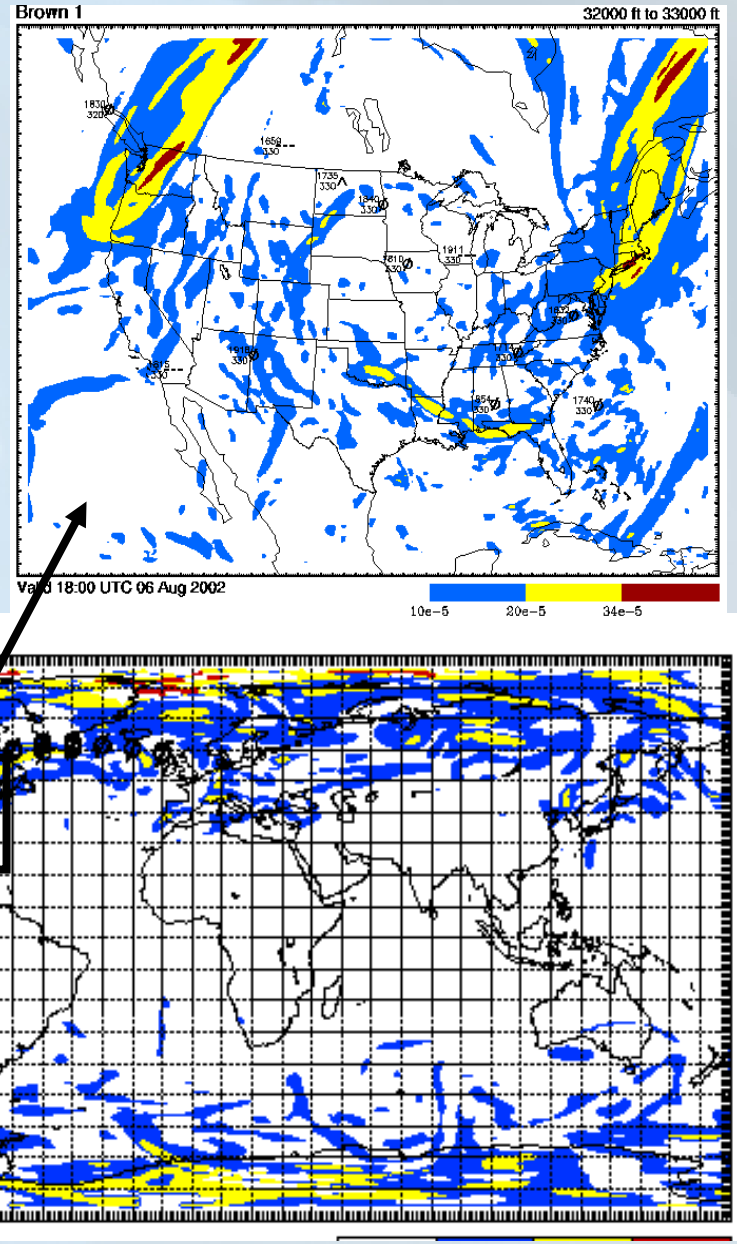
NCAR





Global GTG

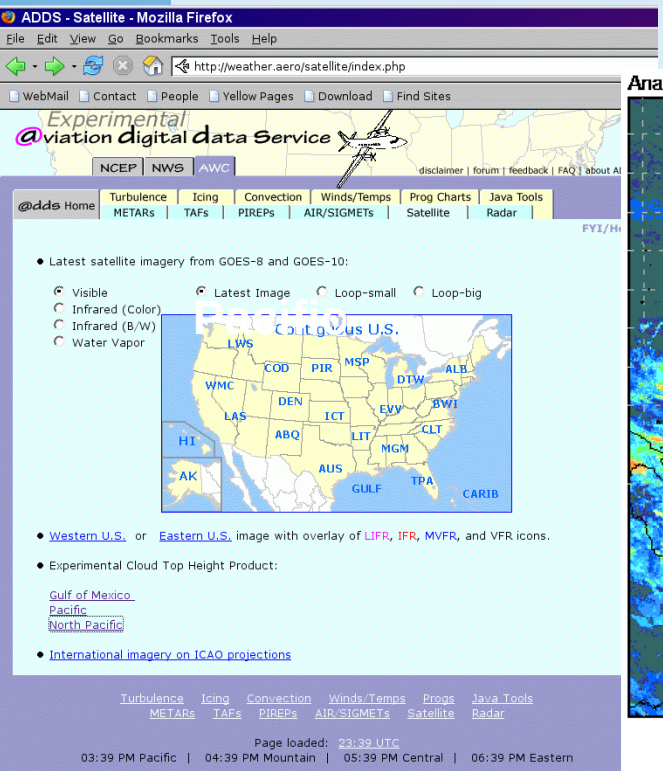
- Uses NOAA's GFS model
- Diagnoses and forecasts of CAT > FL200
- Status
  - D3 was expected in 11/07
  - Operational early 2010
  - Delayed or cancelled

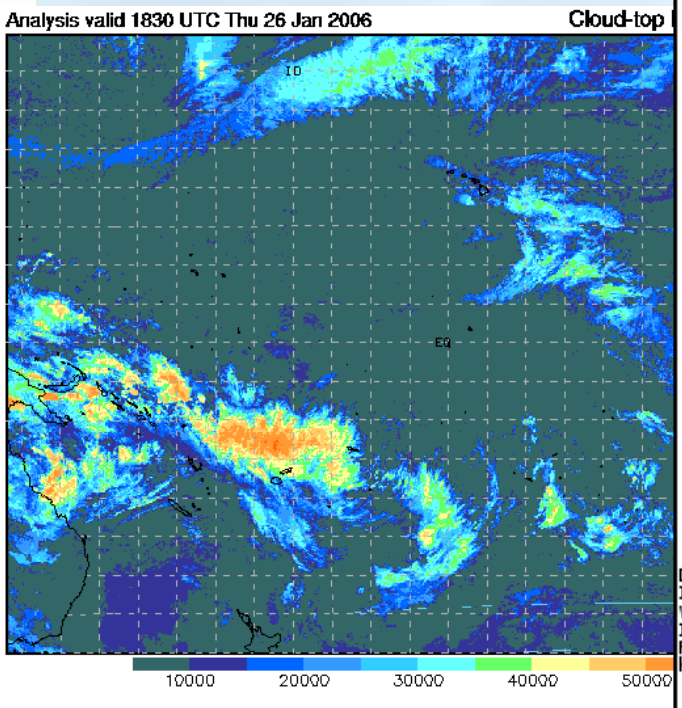


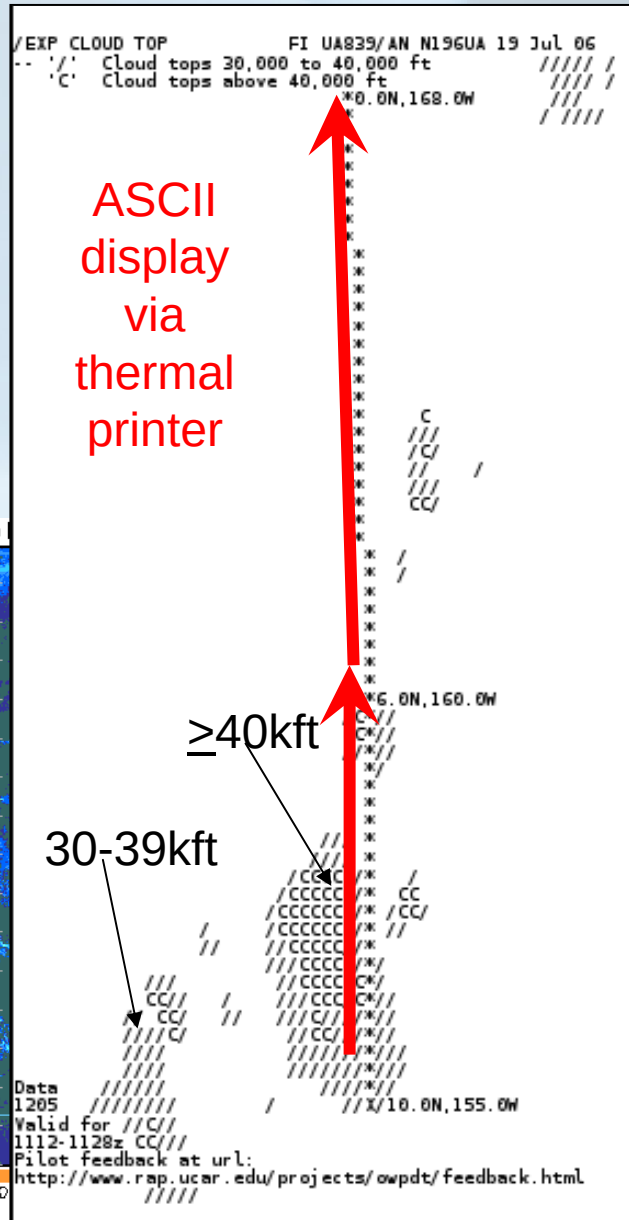
Example: Brown's index at FL320 06 Aug 2002 18Z Upper: RUC20 Lower: GFS

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







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

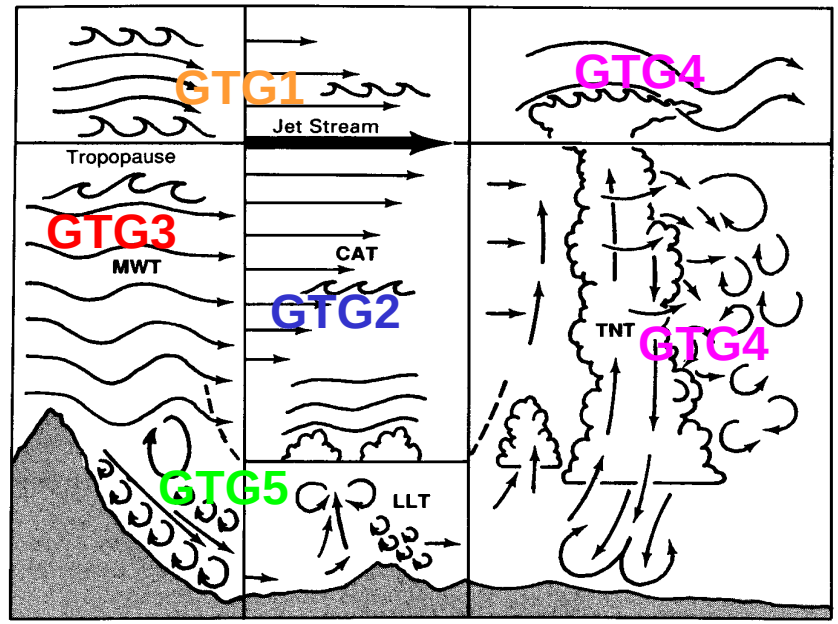


Figure 1-16. Aviation turbulence classifications. This figure is a pictorial summary of the turbulence-producing phenomena that may occur in each turbulence classification.

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