

# **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

```

0330 AOC MENU
DATA
<FLIGHT ATC REQUESTS>
DATA
<LOAD NWA REQUESTS>
DEPT/ RECEIVED
<ENROUTE MESSAGES>
DATA REPORTS
<ARRIVAL FLT PROGRESS>
REPORTS
MAINTENANCE>
<HELP

```

```

0330 AOC REPORTS
ENROUTE
<FREE TEXT RETURN>
<PINK SHEET DIVERT>
ENTER/CONTINUE
<POSITION ENTER>
EON UPDATE/
<TURBULENCE EXIT HOLD>
GATE POST/
<IN RANGE
AOC MENU>

```

```

0330 AOC TURB 1/3>
0 MODERATE 4
<SMOOTH MODERATE>
1 5
<OCC LIGHT MOD/SEVERE>
2 6
<LIGHT SEVERE>
3 7
<LIGHT/MOD EXTREME>
-----
<PREV MENU AOC MENU>

```

→ Detail  
(Options)

```

0330 AOC TURB 2/3>
FROM ALT TO ALT
FL 360 FL [ ]
FROM POS TO POS
DENDU 50N040W
ABEAM DIR ABEAM DIR
[ ] DEG [ ] DEG
ABEAM DIST ABEAM DIST
[ ] NM [ ] NM
SMOOTH ALT? REMARKS
FL [ ] NEXT PAGE>
<PREV PAGE AOC MENU>

```

```

0330 AOC TURB 3/3>
ENTER REMARKS :
A/C ABOVE OUR FL REPORT
LGT/MDT TURB
[ ]
[ ]
*SEND
NEXT PAGE>
<PREV PAGE AOC MENU>

```

# Delta Turbulence Reporting

## Manual Reporting: Text of Turbc Area Report

REPORTED TURB LEVEL: **SMOOTH**.  
FROM FL: **360** TO ---  
FROM FIX: **DENDU** TO FIX: **50N040W**.  
FROM ABEAM: / TO ABEAM: /  
SMOOTH FLIGHT LEVEL: **360**.  
PILOT REMARKS: **A/C ABOVE OUR FL REPORT LGT/MDT TURB**

## Automated Reporting: g-Load

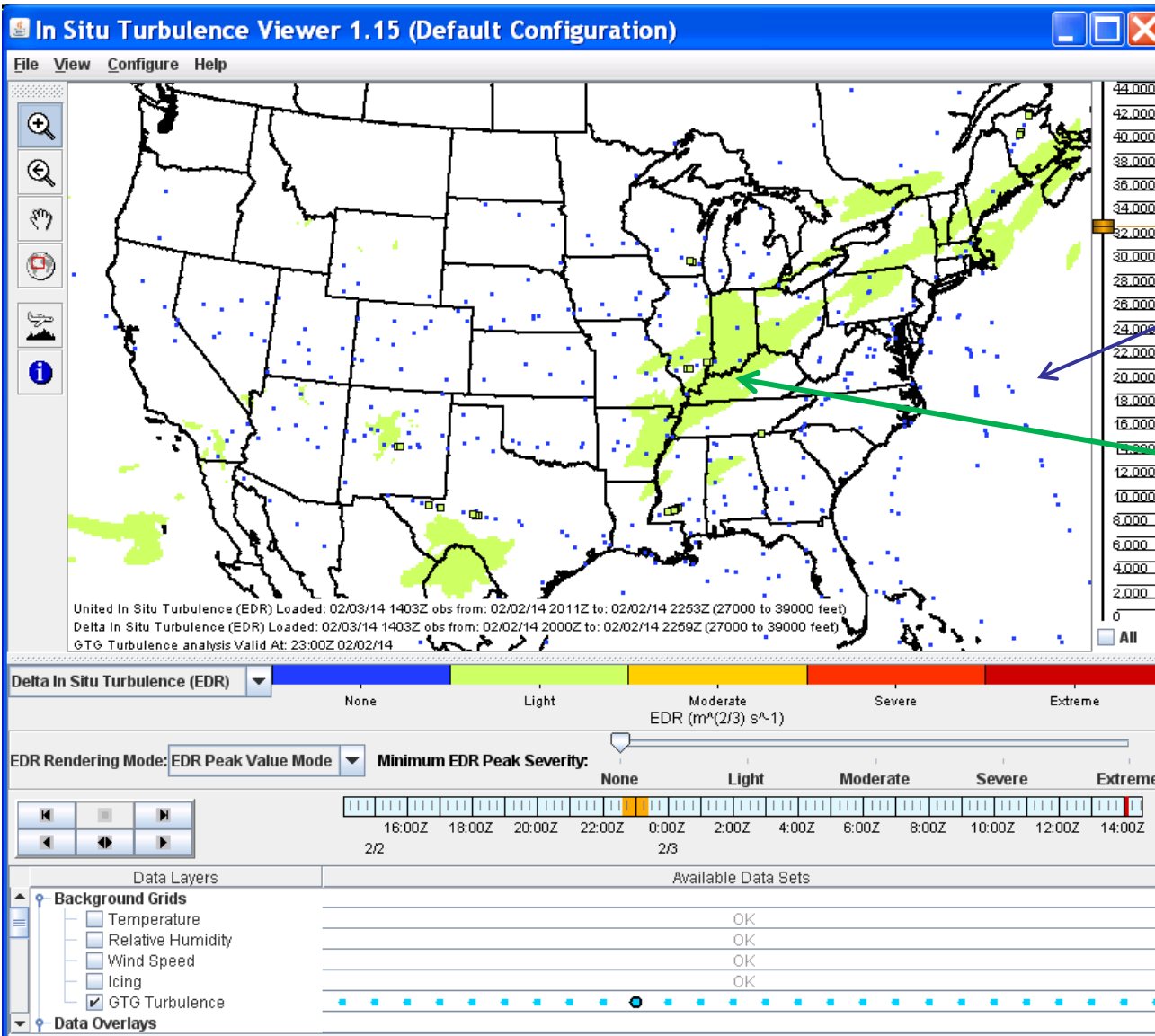
**Not accessed real-time. Pulled & Used for accident investigations.**

## Automated Reporting: EDR Text

N33829W11874306560986P0952140120XXXX25::**30NXW**  
N33755W11872206571300P0422240250XXXX25::**30W/X**  
N33721W11861306581482P0022310440XXXX2500**1Y20**)

- 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



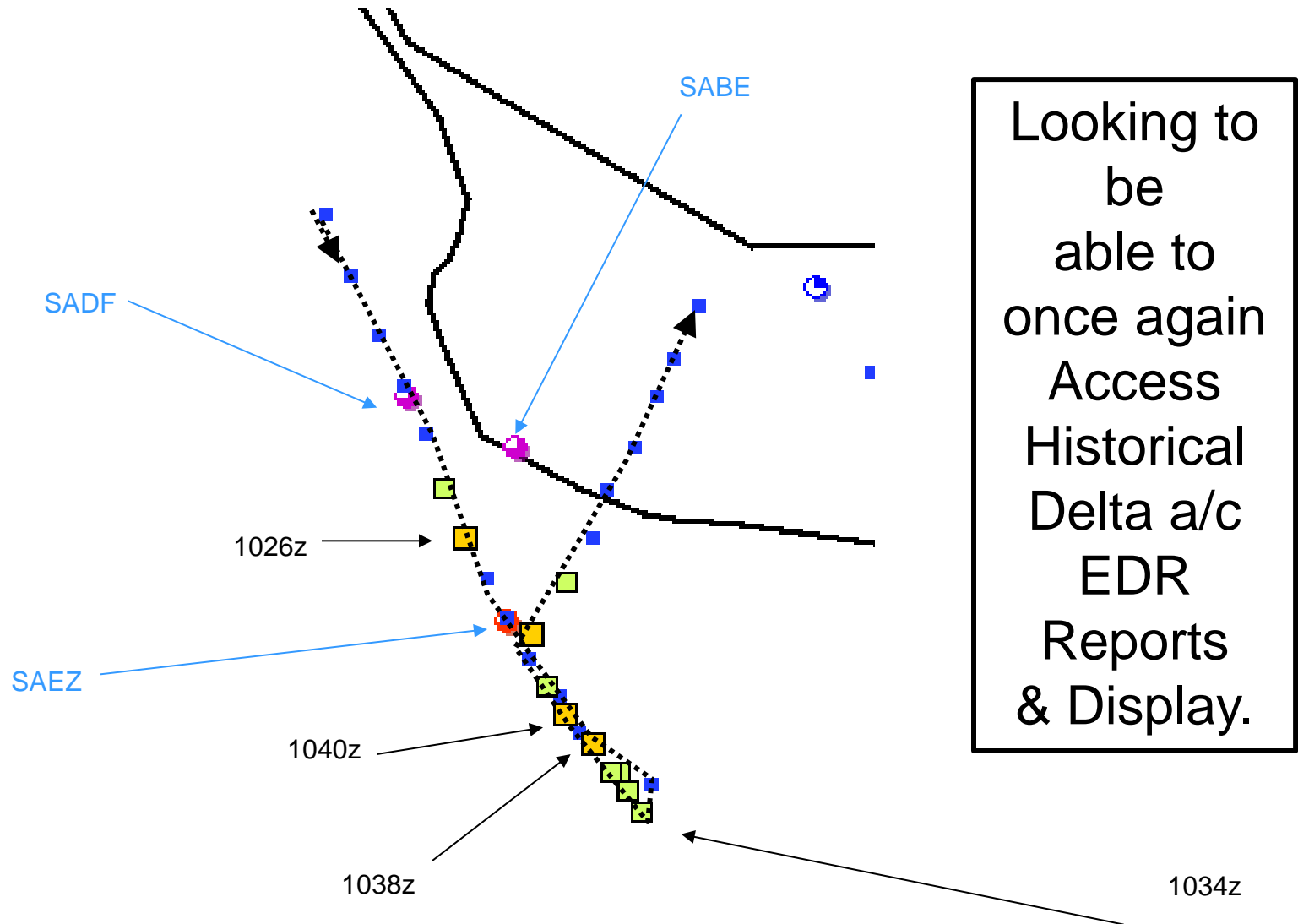
- Included Display of:
- Delta's EDR Reports (color coded dots)
  - &
  - GTG Forecasts (color coded areas)

Currently Working  
w/ Delta IT to be  
able to Access:

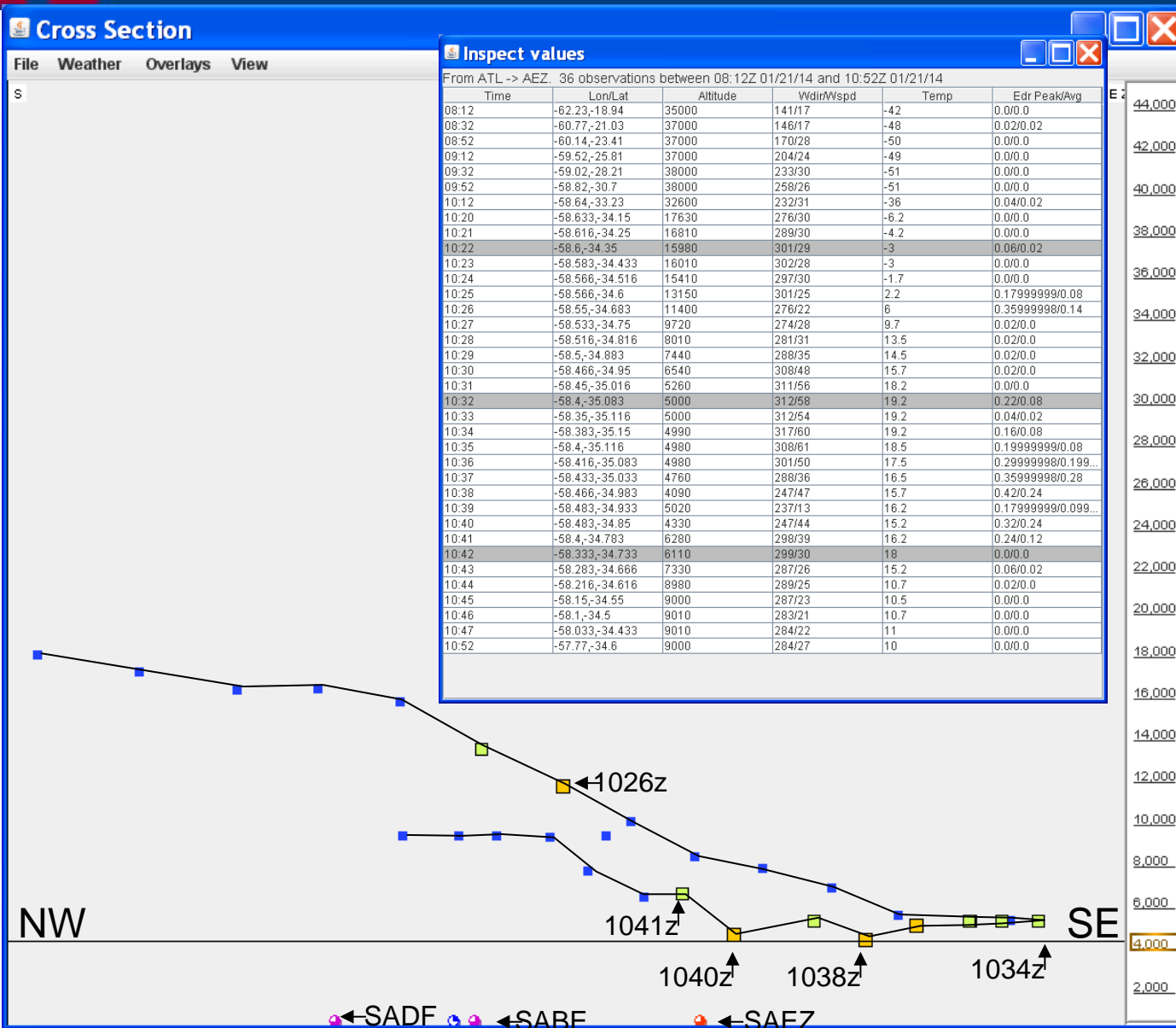
- Viewer 2.2.9

# Viewer 1.15 Capability

## EDR Turbulence Plotted w/ Flight Path



# Viewer 1.15 Capability Cross Section with Flight Path & Values



**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



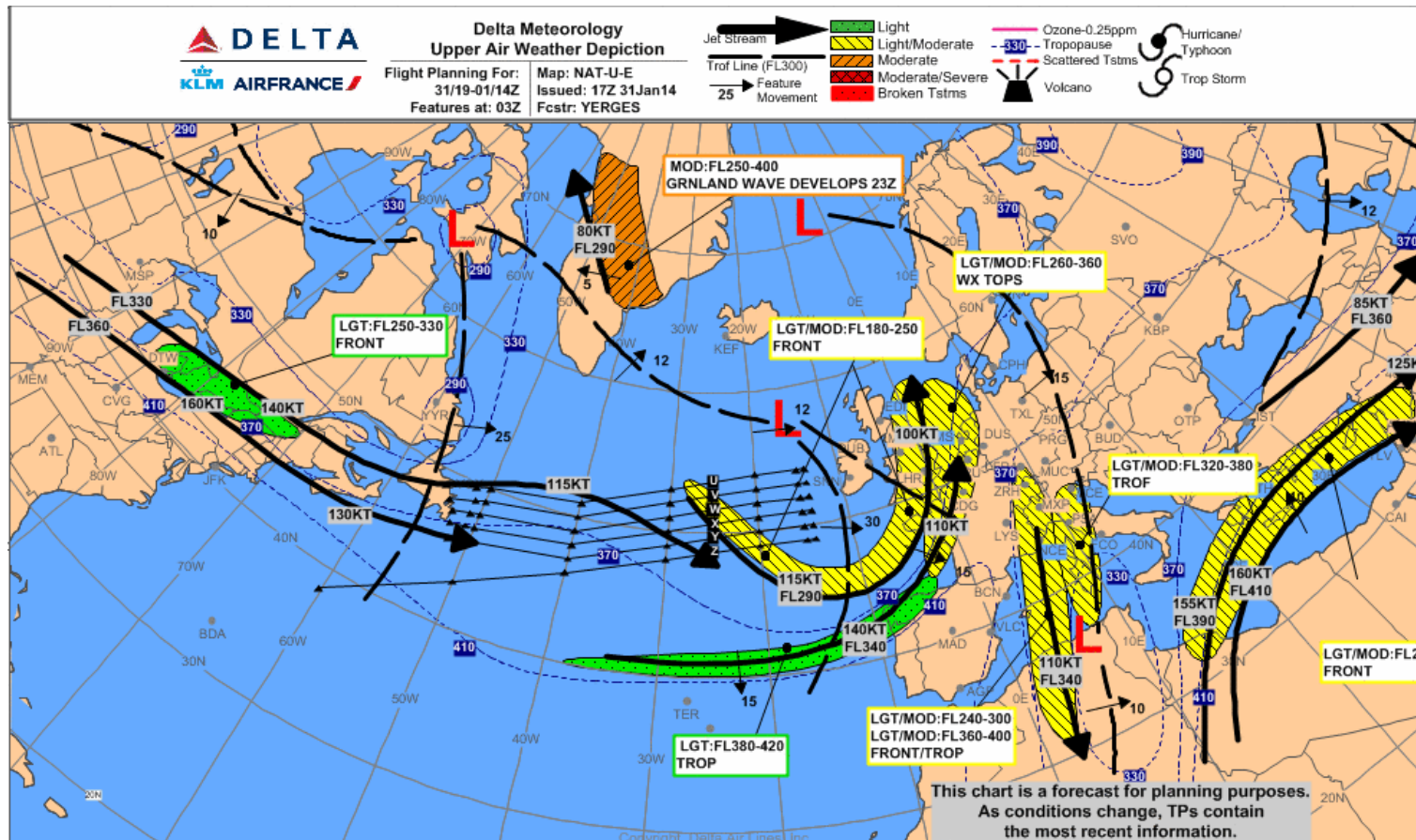
How does Delta Air Lines  
prepare for En Route  
Turbulence & other  
Weather Hazards?

**Delta has products & processes in place for these en route weather hazards:**

- Turbulence
- Mountain Waves
- Thunderstorms
- Ozone
- Volcanic Ash
- Space Weather

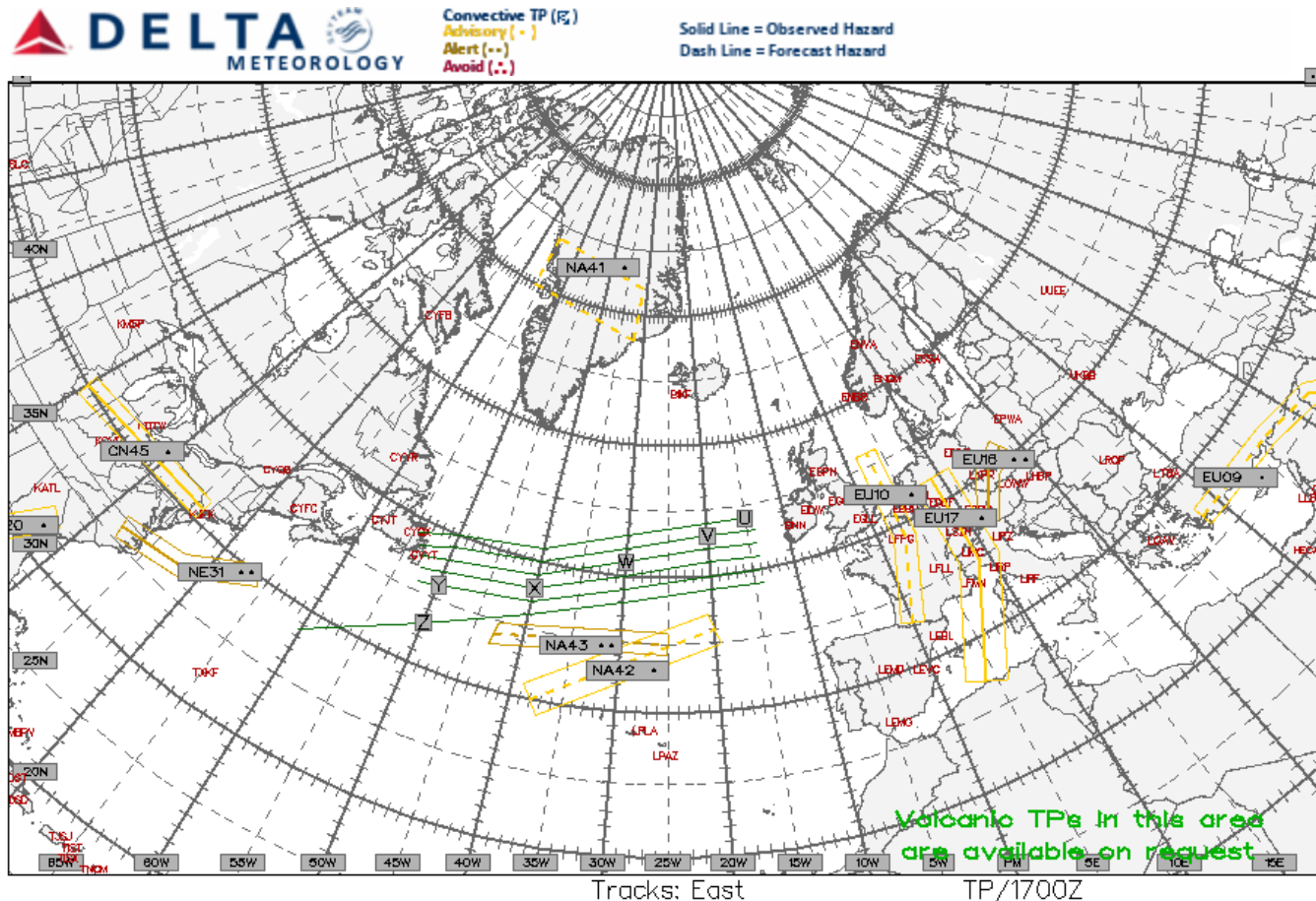
# En Route Hazards – Depictions

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.

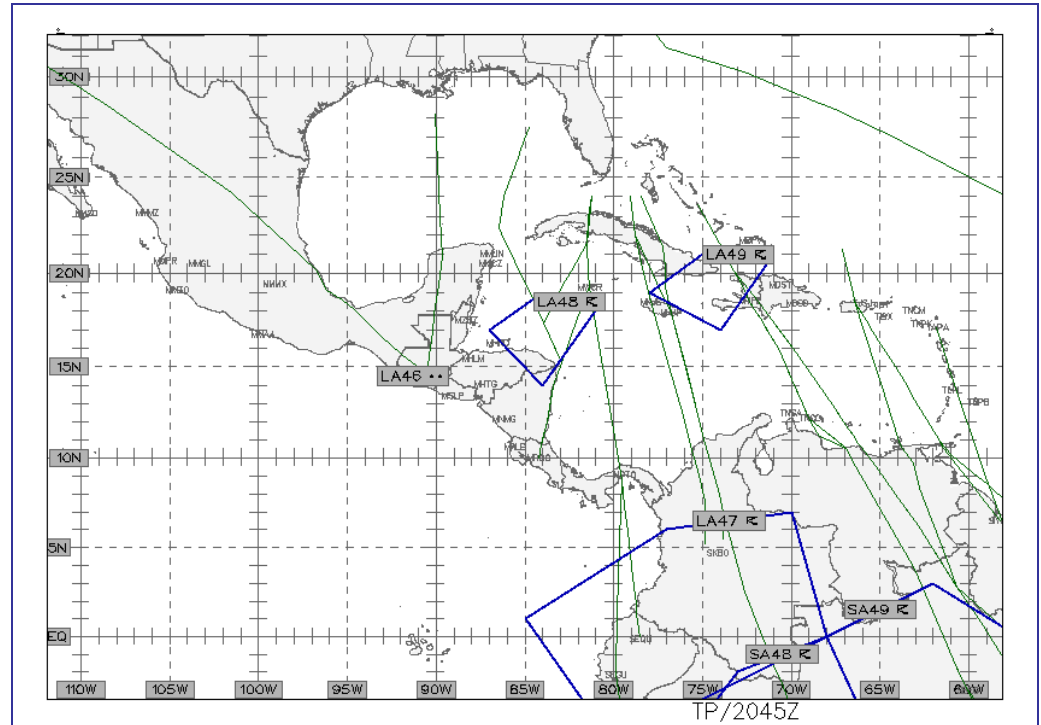


# En Route Hazards – TP's

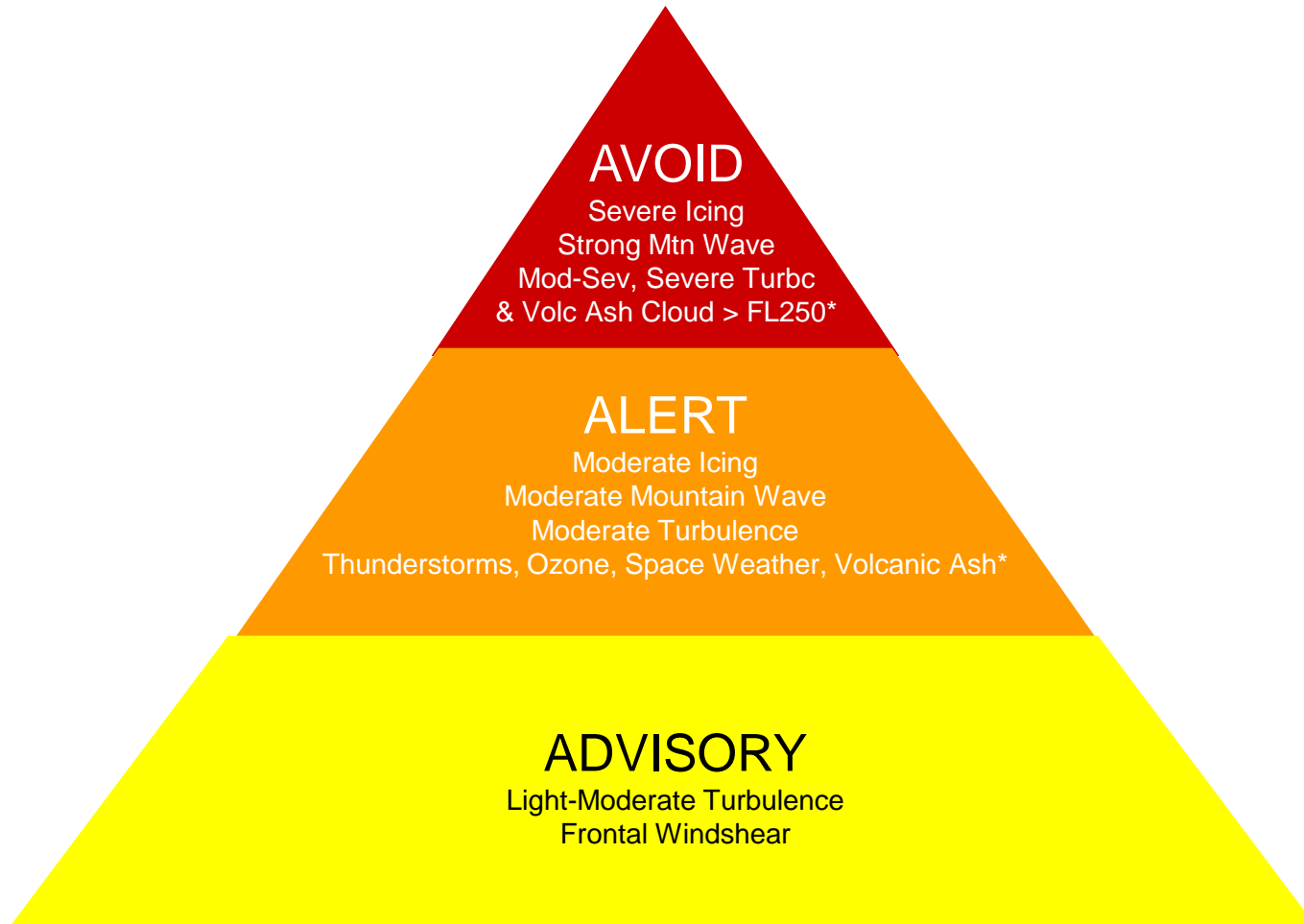
Turbulence Plots (TPs) are tactical flight planning/flight following tool that are issued and updated as conditions warrant and contain most current info.



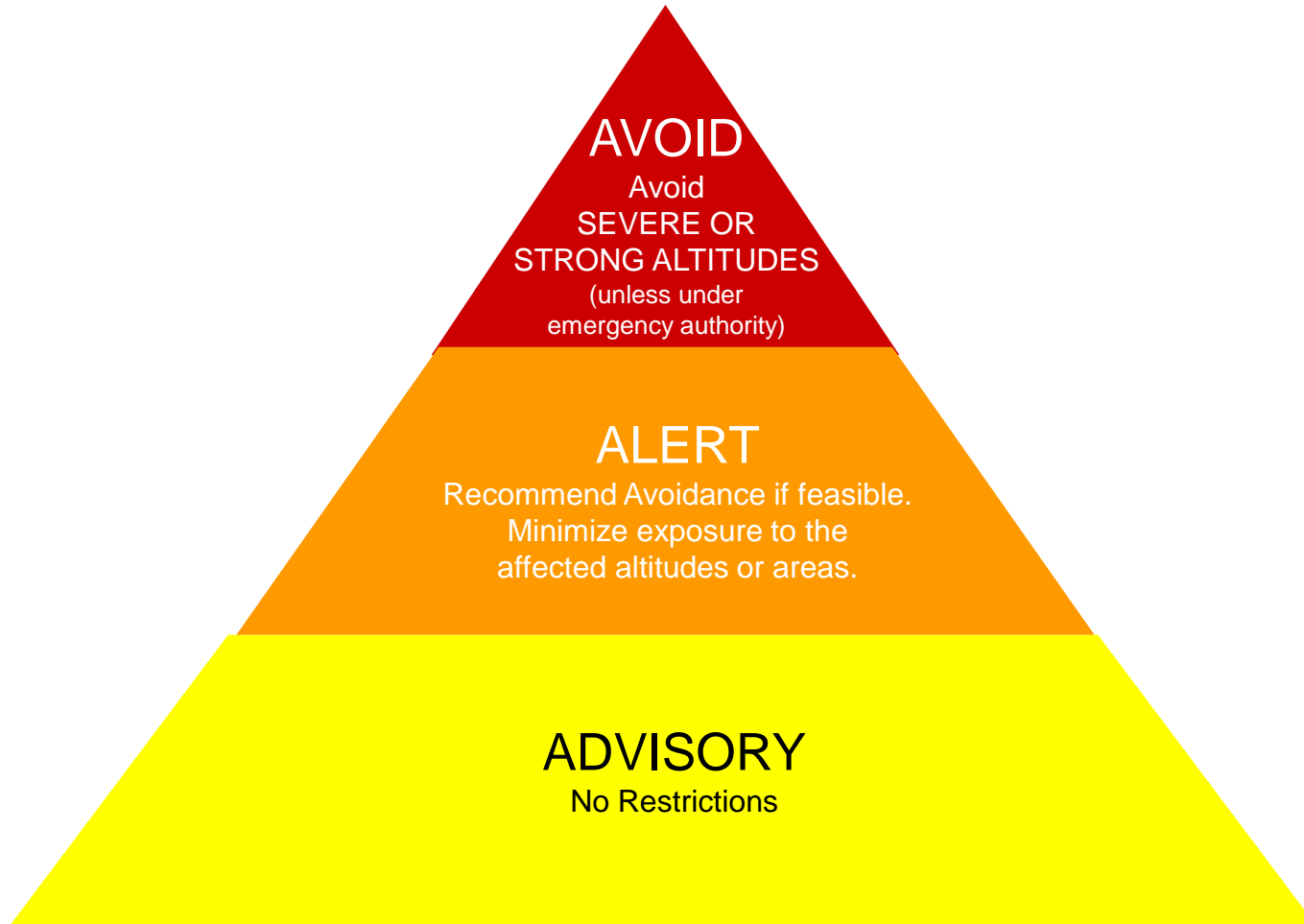
- Consistent product no matter where in the world
- All hazards
- Delta size aircraft
- Updated as needed



# TP Types and Hazard Intensity



# Avoidance Policy and Procedures

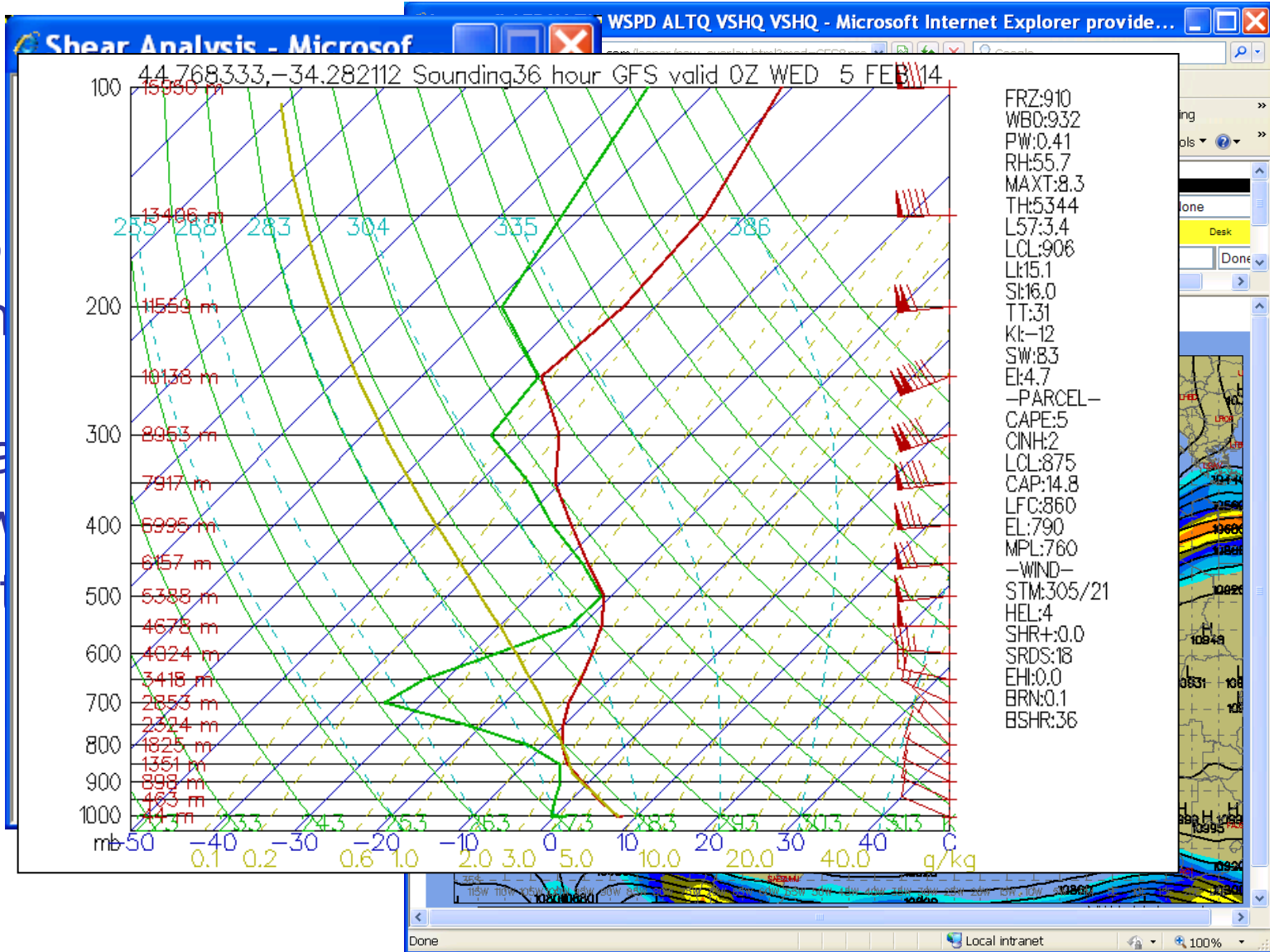


What tools do Delta Meteorologist use to create these manual and human-in-the-loop products?



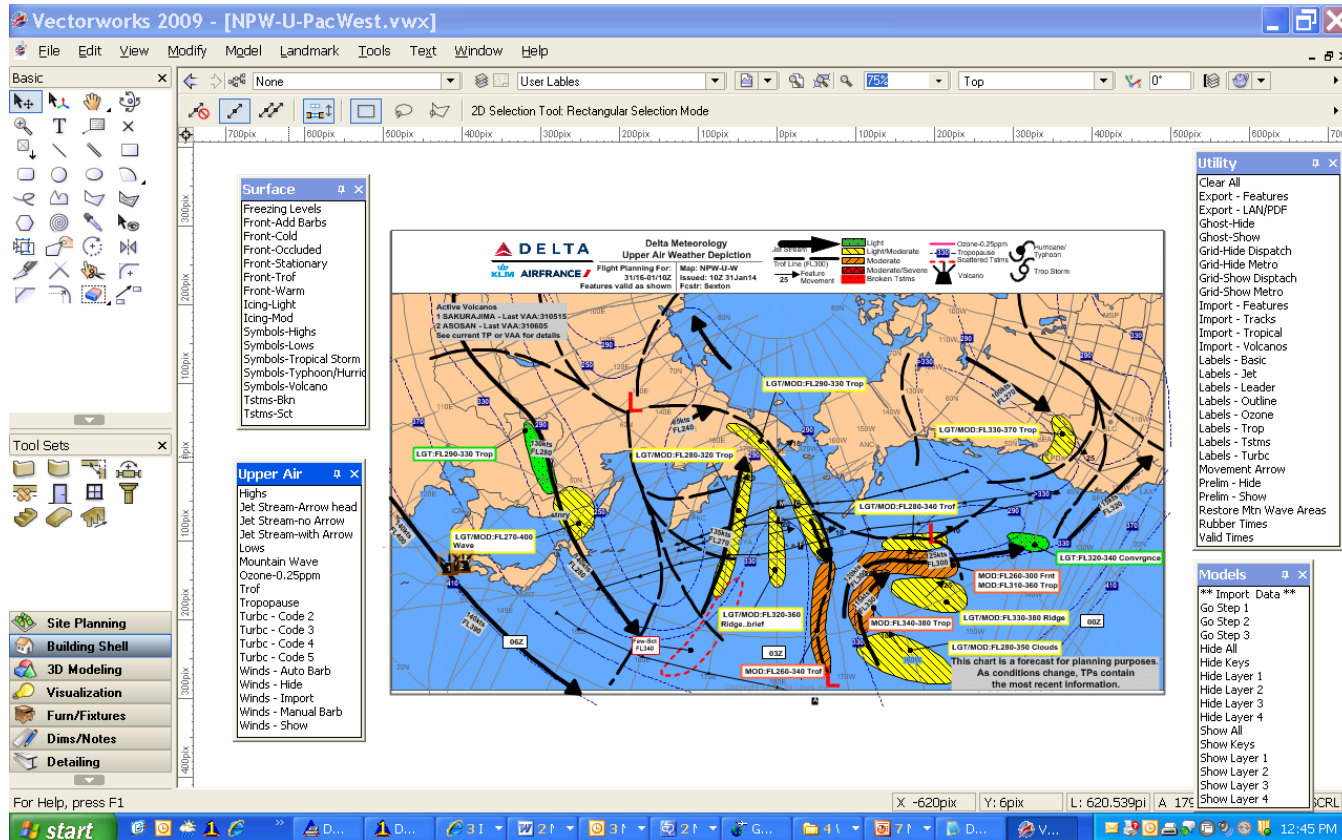
# Meteorology Tools – Looper

Meteo  
can ch  
model  
and pa  
to view  
animat



# Meteorology Tools – Vectorworks

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

The screenshot displays the TMS web application interface. The main window shows a map of the Northeastern United States and surrounding waters. The interface is divided into several panels:

- Top Panel:** Contains navigation links for various data sources like DeltaNet, Metro Portal, and Flight Control. It also includes a search bar and a 'Layers On/Off' menu.
- Left Panel:** A sidebar with multiple configuration sections:
  - Update Date:** Shows the last update time (16:12:22) and an 'Update' button.
  - Stephanie Klipfel - Saved Settings:** A dropdown menu set to 'None' with 'Add', 'Change', and 'Delete' actions.
  - Filters:** Includes checkboxes for 'RW/DL', 'Large A/C', and 'Small A/C', with a 'Show All' button.
  - Overlays:** A section for selecting data overlays, currently set to 'None'.
  - Animation Parameters:** Controls for 'Start Time', 'End Time', and 'Interval'.
- Right Panel:** A vertical sidebar with a 'Mode' dropdown set to 'None' and a 'Show' button. Below it are 'Since' and 'Last' filters.
- Main Map Area:** Displays a map with various overlays. A red box highlights a specific area over the Chesapeake Bay region, with labels 'NE14' and 'NE15' indicating TP (Turbulence Point) lat/lon points. The 'Layers On/Off' menu at the top of the map area is expanded, showing checked options for 'Basemap', 'Satellite', 'BRet', 'ETop', 'PIREPs', 'RAOBs', 'Winds', 'VAAS', 'TPs', 'Tracks', 'Lat/Lon', and 'Dots'.
- Bottom Panel:** A 'start' button and a text prompt: 'Contains commands for working with the selected items.'

# Meteorology Tools – WxStream

The screenshot shows the 'Delta Air Lines WxStream Editor' web application. The interface is designed for creating meteorological products. On the left, there is a 'Select Product Type' sidebar with options like 'Metro General', 'Metro Regional', 'Metro Station', 'Metro Outlook', 'Other Surface', 'TPs-Enroute', and 'TPs-Station'. Below this is a 'Desk' section with 'Surface' (Domestic/Pacific) and 'Status' (Published) options. A table lists various product entries with columns for Region, Type, and End time.

Region	Type	End
AF33	TSTMS	04/0600Z
AF32	TSTMS	04/0600Z
AF31	TSTMS	04/0600Z
EU47	TURBC-OTH	04/0600Z
EU46	TURBC-OTH	04/0600Z
EU45	TURBC-TROP	04/0600Z
CN15	TURBC-UF	04/0300Z
AO11	TURBC-TROP	04/0800Z
NP14	TSTMS	04/0223Z

The main content area is titled 'WxStream CREATE' and includes a 'Welcome Stephanie Klipfel' message. It features a 'TP Region' dropdown set to 'Region', a 'TP Area' input field, and a 'Hazard' section where 'TURBC-TROPOPAUSE' is selected. The 'Source' is set to 'Forecast'. The 'Area' field is empty, with an 'Import Lat/Lon' button. The 'Position Time' is set to the current time. The 'Alts' section has 'Low' and 'High' inputs and radio buttons for codes (Code 3 - LGT/MOD, Code 4 - MOD, Code 5 - MOD/SEV). The 'Mvg' section has 'Frm' and 'And' inputs and radio buttons for directions (All, North, South, East, West). The 'Info (optional)' field is empty. The 'Begin(Optional)' field has 'Begin' and 'End' inputs. The 'Default' section has radio buttons for time offsets (plus 2 hours, plus 3 hours, plus 4 hours, plus 5 hours, plus 6 hours, plus 12 hours). At the bottom, there are 'Cancel', 'No Tps To Cancel', 'Enter Other Region: Region', and 'Publish' buttons. The footer shows the date '2014 Feb 03 20:39:52', the meteorologist 'Klipfel', and the version '1.1.13 (12/26/13 11:30PM EST)'.

Template for  
all our  
products:  
Import TP  
lat/lon from  
TMS.

How do weather  
products get distributed  
at Delta?

# Who's Responsible?

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.

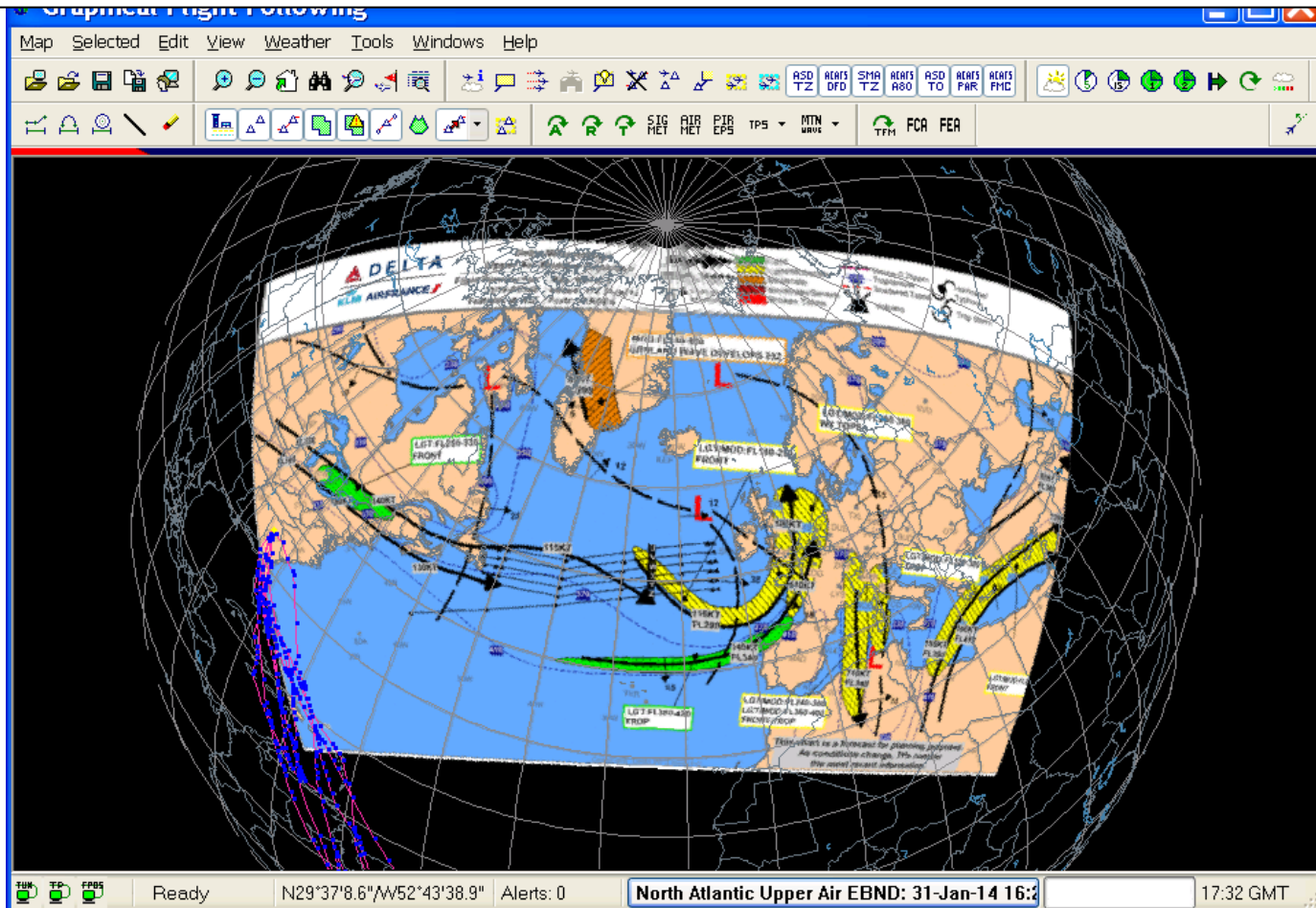
The Dispatcher is responsible for:

- 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.



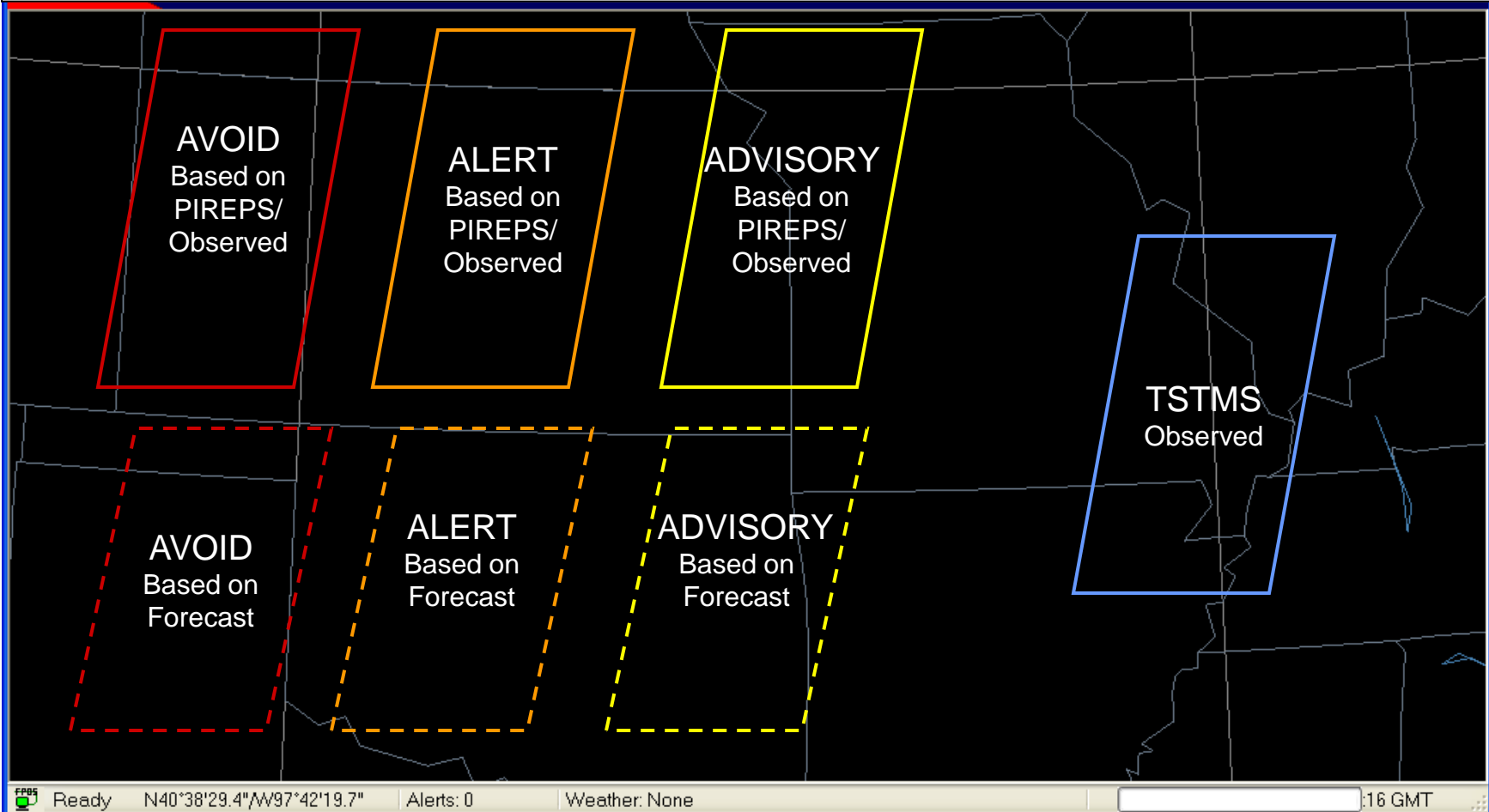
# Depiction Distribution to Dispatchers

Upper Air Depictions can be an overlay on Graphical Flight Planning tool



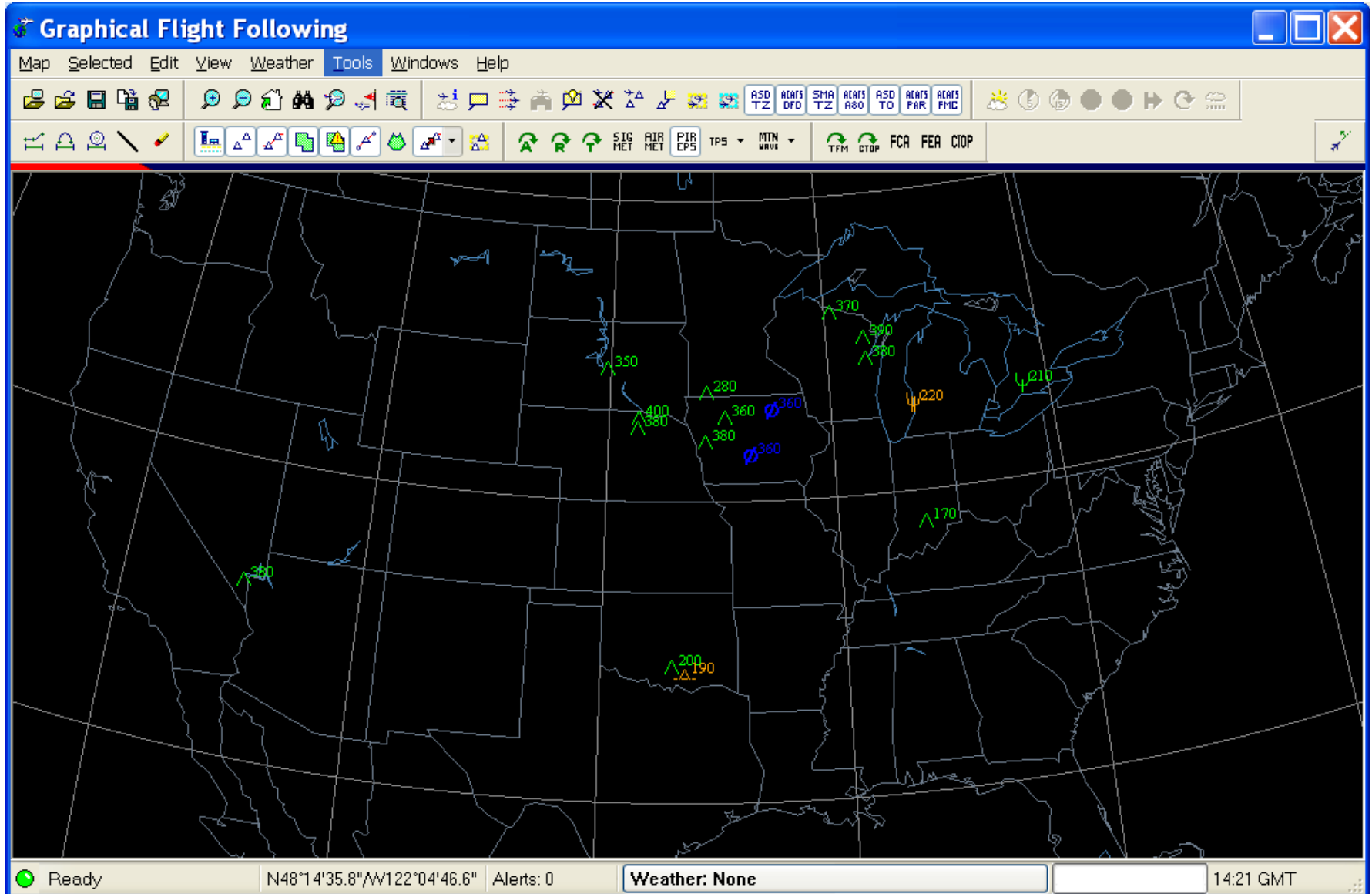
# TP Distribution to Dispatchers

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

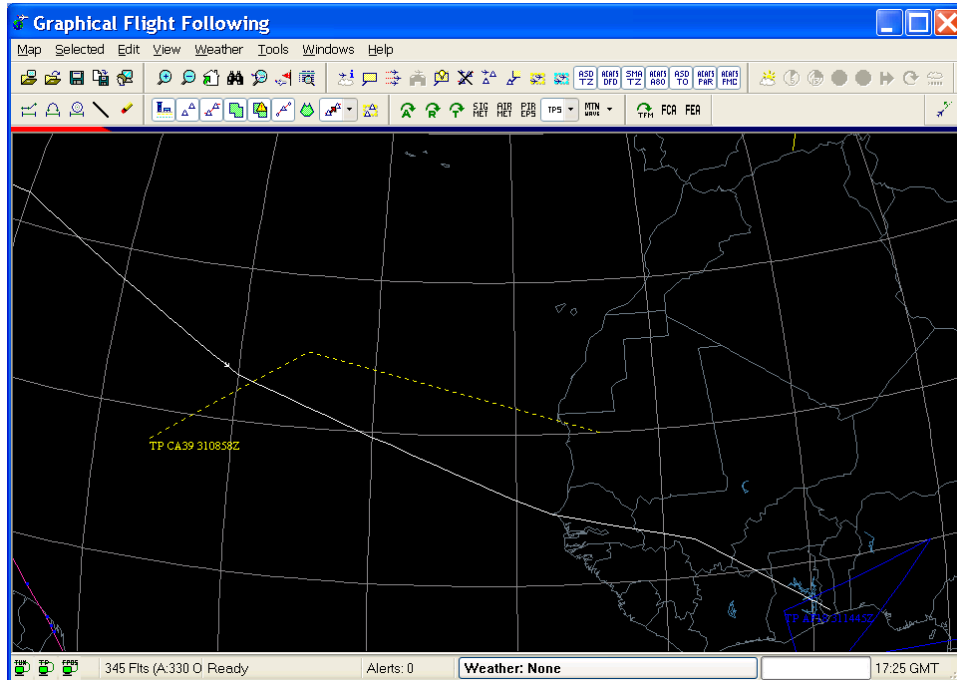
## TPS-ENROUTE

```
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
```

her Depictions,  
& other weather  
ucts are available  
e intranet.

ternational flights  
copy of Upper  
epiction, TPs  
pilot reports prior  
parture.

# Product Distribution to Pilots – En Route



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

ACARS-NNNN TP REQUEST		ACARS-NNNN DOM REGION	
1L	*LISTING	1R	NE SE
2L	<BY DOM REGION	2R	*NORTHEAST SOUTHEAST*
3L	<BY INTL REGION	3R	CN CS
4L	<BY NUMBER	4R	*CENTRAL NO CENTRAL S0*
5L		5R	NW SW
6L	<RETURN HH:MM	6R	*NORTHWEST SOUTHWEST*
			A H
			*ALASKA HAWAII*
			OTHER
			*[]
			<RETURN HH:MM

# What's Next?

# Integrating Human & Model Forecast

Take advantage of advances in technology to move Delta <sup>2</sup> into a real-time graphical world.

- Tablets in the cockpit
- Model based forecast

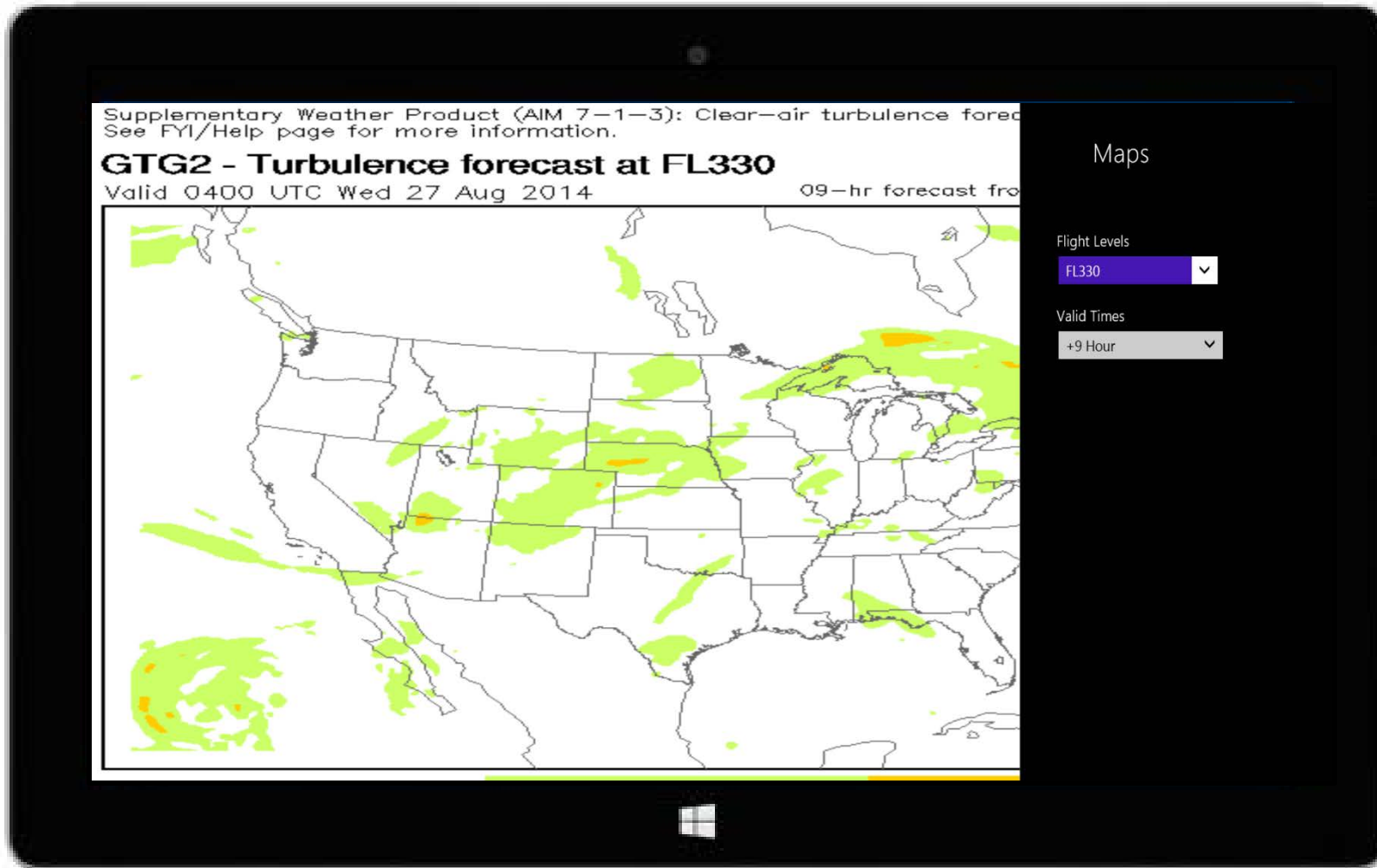


**Step 1:** Provide access to current products on tablet

**Step 2:** Enhance Products & integrate global data into dynamic display

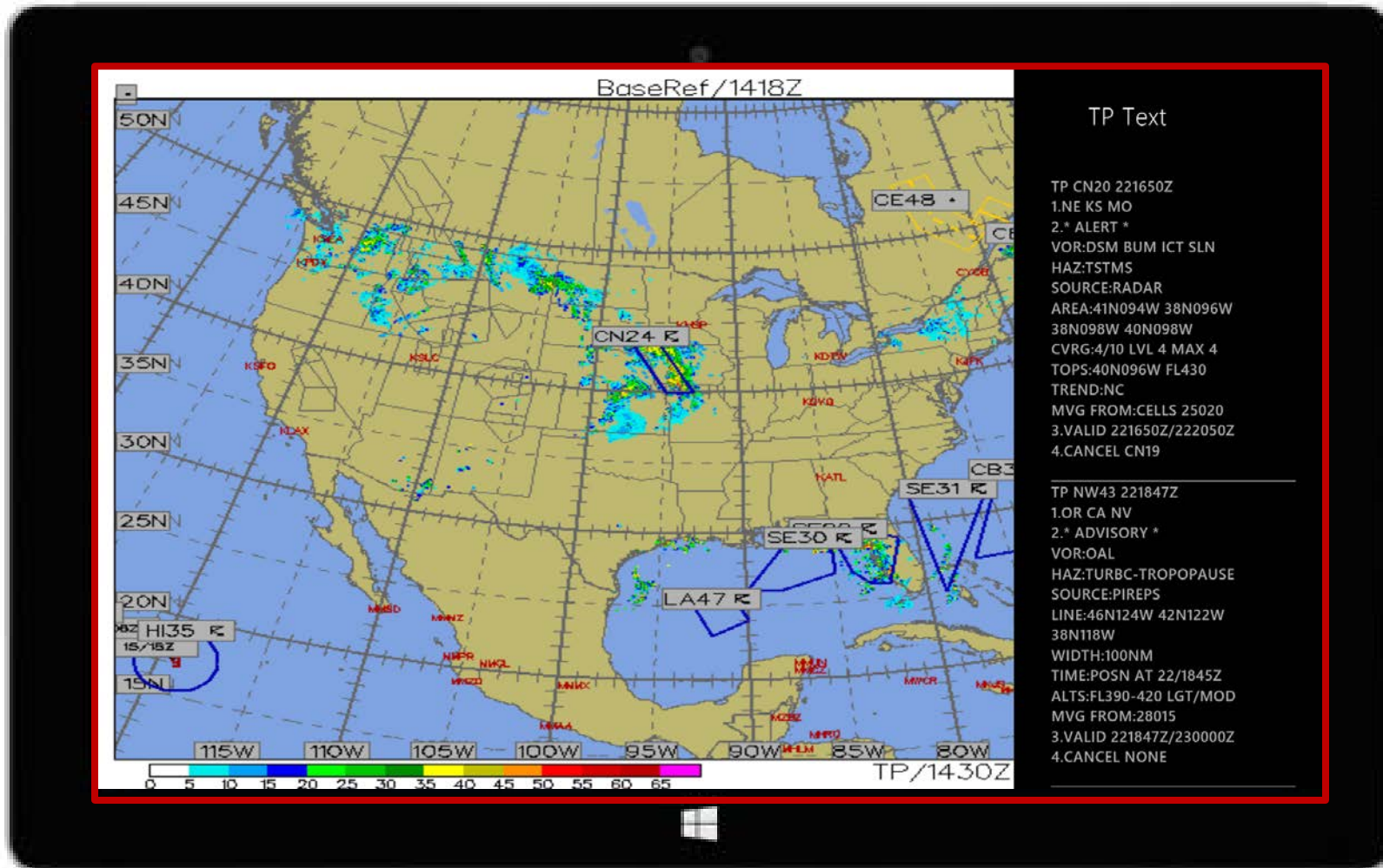
**Step 3:** Transition Meteorology to over-the-loop instead of manual & in-the-loop forecast and provide flight specific graphics

# 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



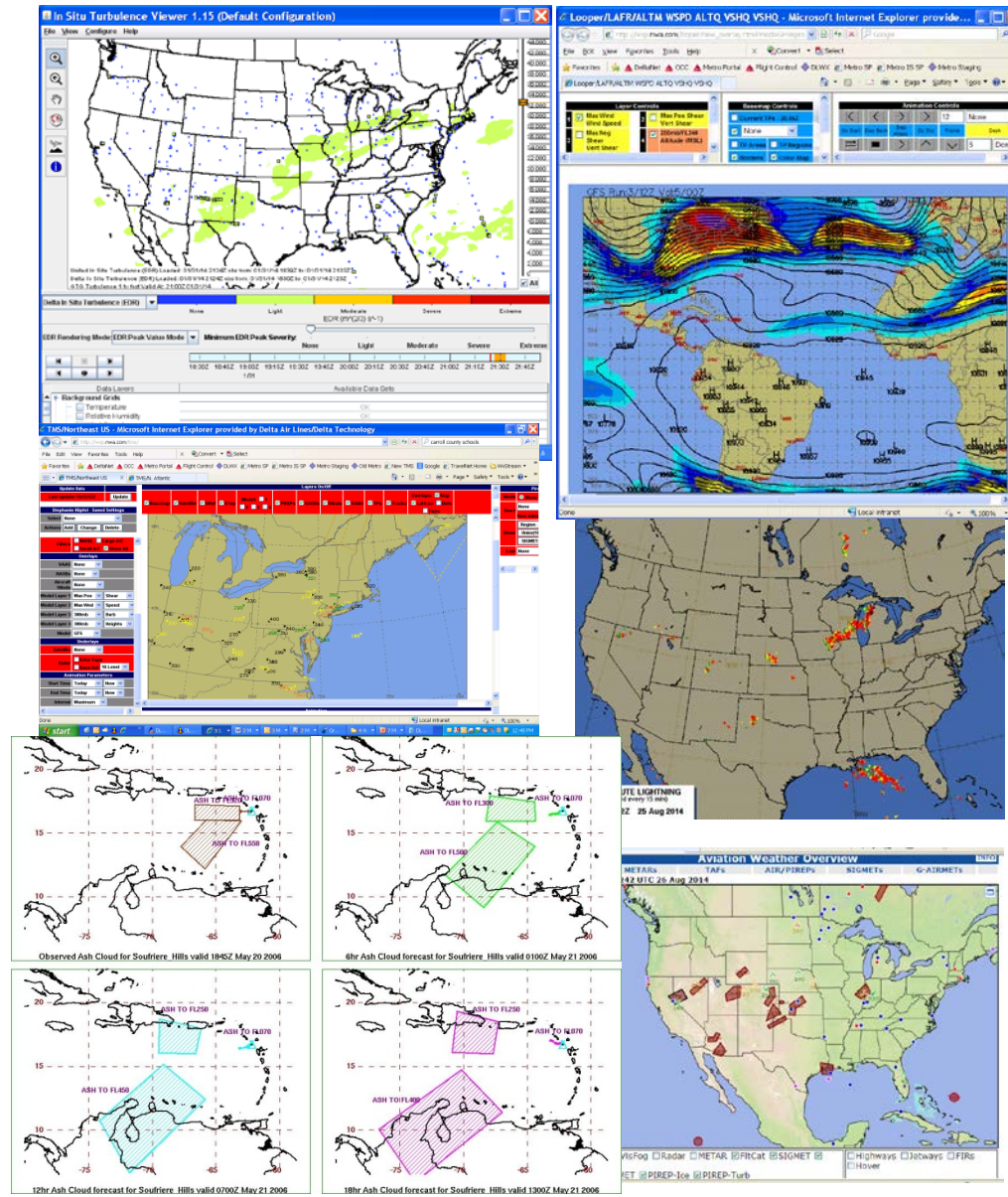
Delta Meteorology TPs (graphic & text)  
with radar overlay

# Step 2: Enhance Products & Integrate Data on a Dynamic Display

Build a system that can integrate global data:

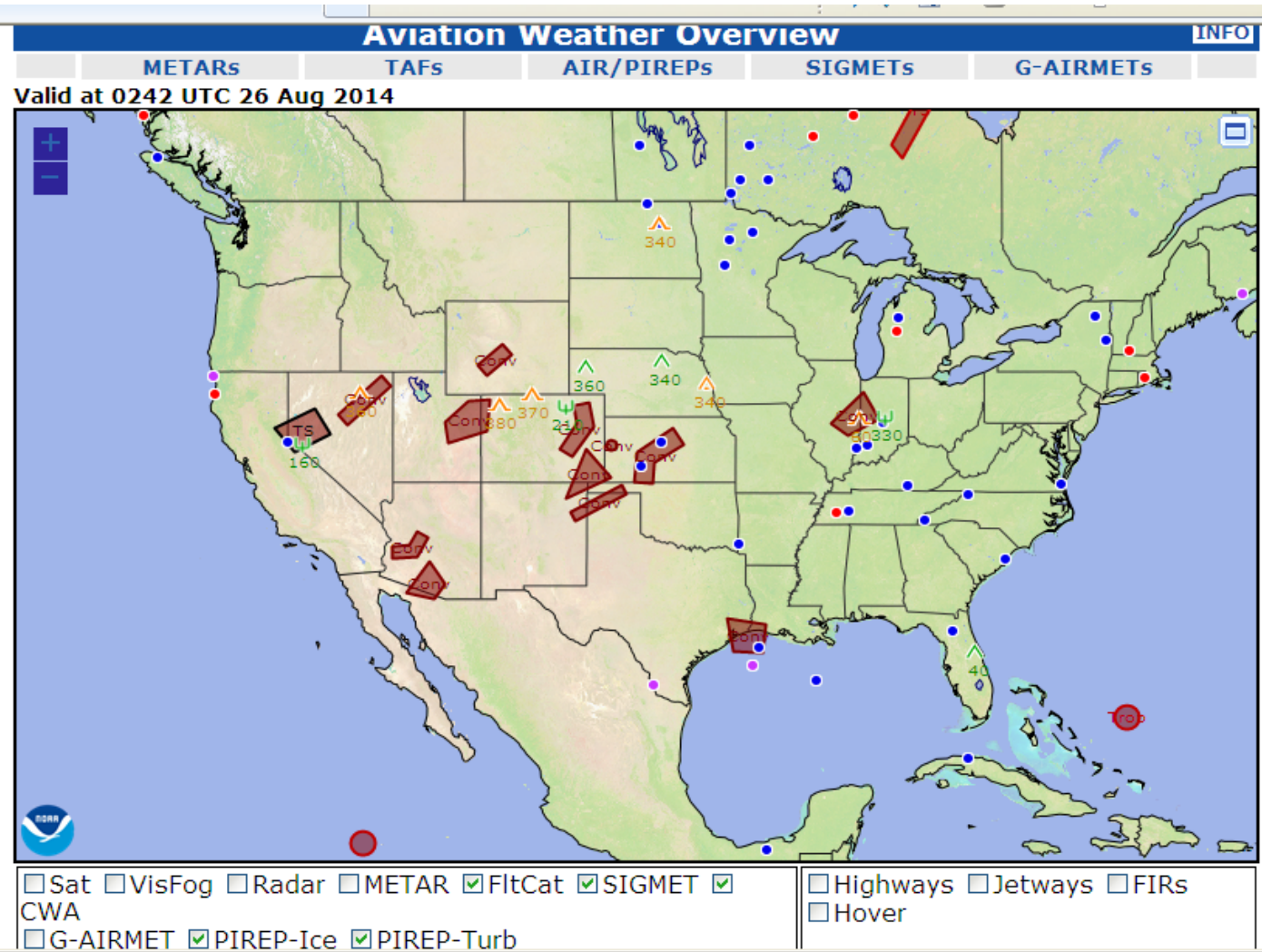
- Model data, including GTG
- TP's & Depictions
- Turbulence Reports, including traditional and auto-generated
- Satellite
- Lightning
- Radar
- SIGMETs
- Volcanic Ash Advisory

Develop tools for pilots, dispatchers & meteorologist using same data for common operation picture.





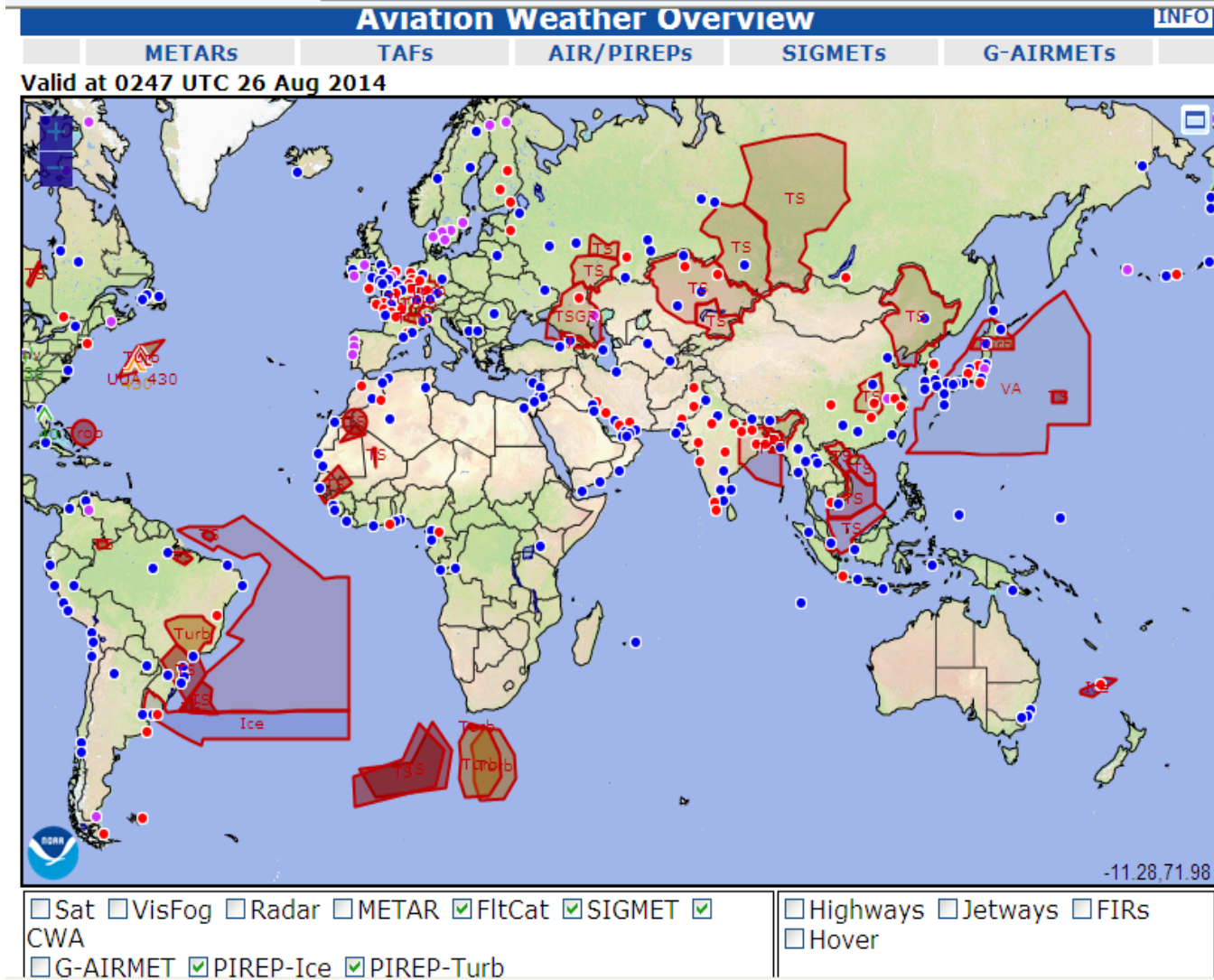
# Aviation Wx Center Display Capability Excellent & Detailed Info



- Detailed & consistent information over US
- Dynamic display with overlay options

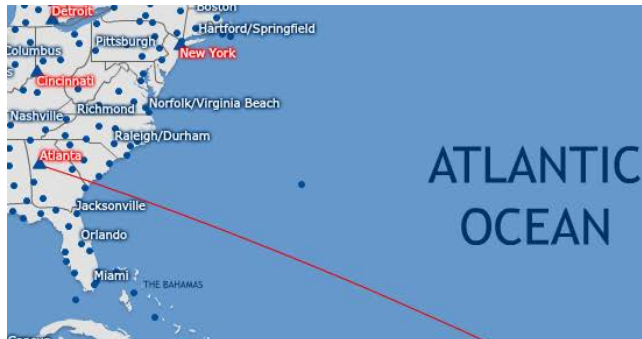
# Aviation Wx Center

## Global Products lack Consistency



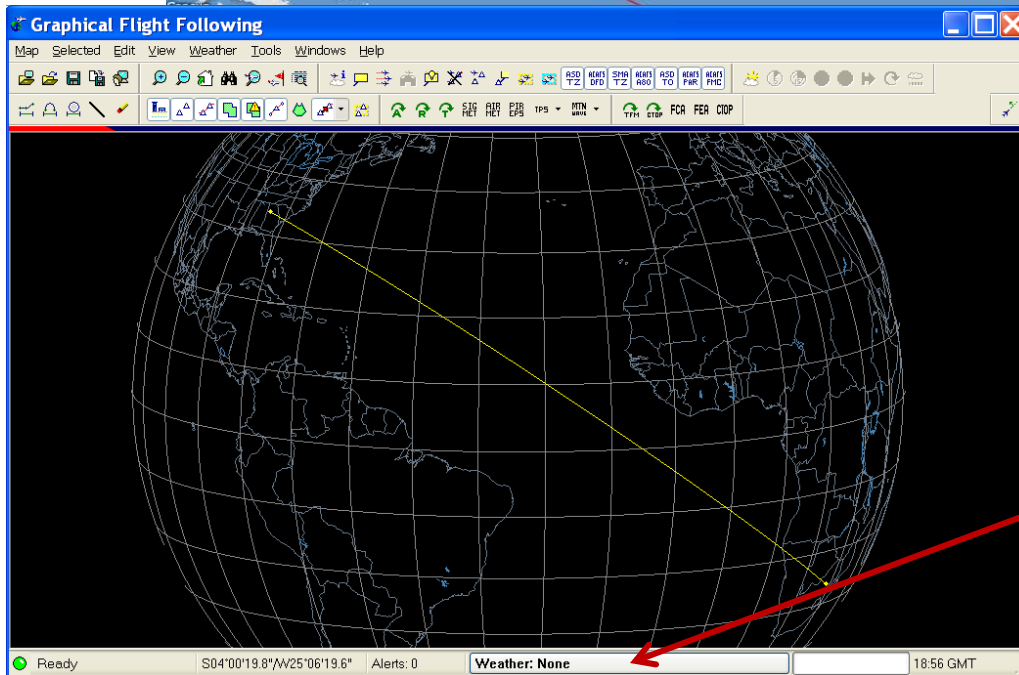
- Global Products lack detail and consistency
- Can not integrate Delta Meteorology Forecast

# 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

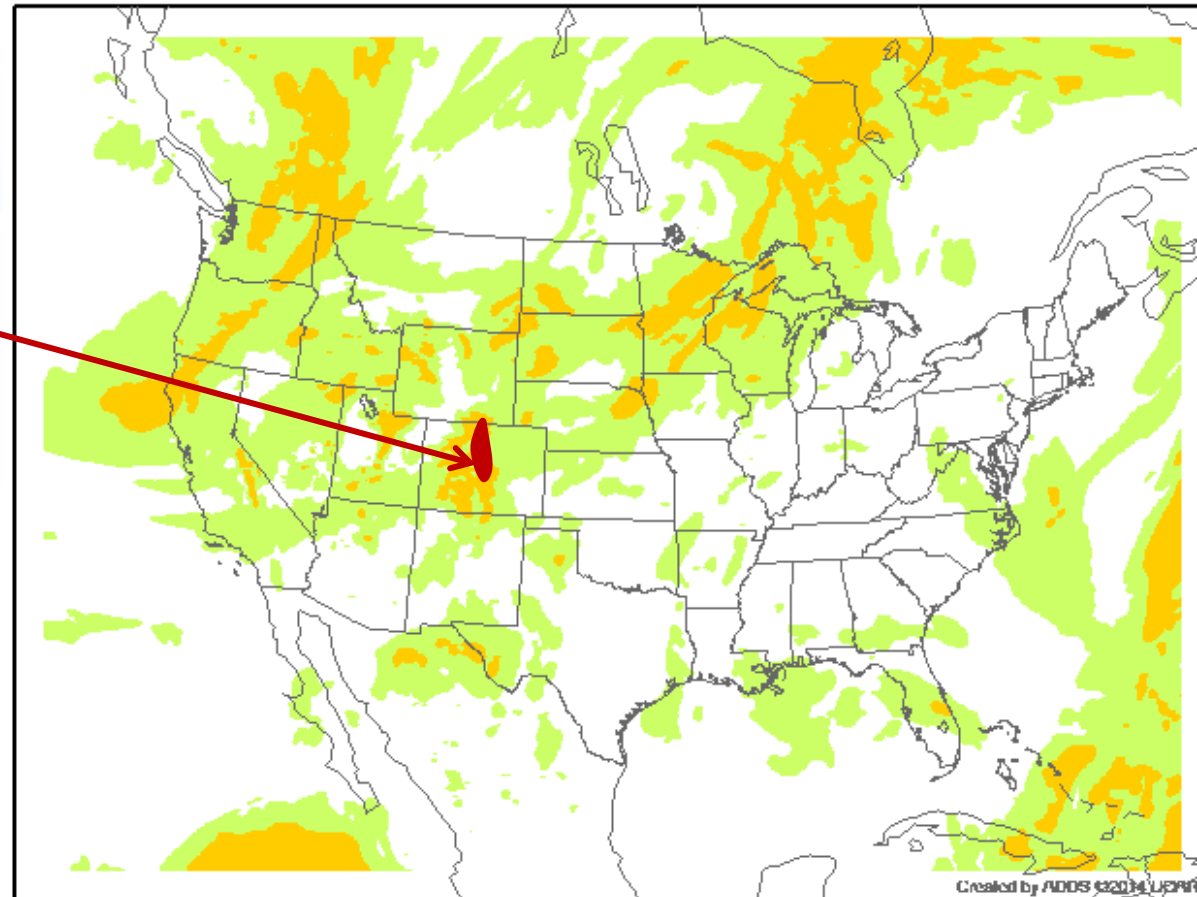
# Step 3: Transition Meteorology to Human Over The Loop as Models Improve

Supplementary Weather Product (ADM 7-1-3): Clear-air turbulence forecast only.  
See FYI/Help page for more information.

## GTG2 - Maximum turbulence intensity (10000 ft. MSL to FL450)

Valid 1600 UTC Mon 25 Aug 2014

02-hr forecast from 1400 UTC 25 Au



Delta Meteorologist  
thinks there is  
potential severe  
turbulence and can  
increase intensity.

None

Light

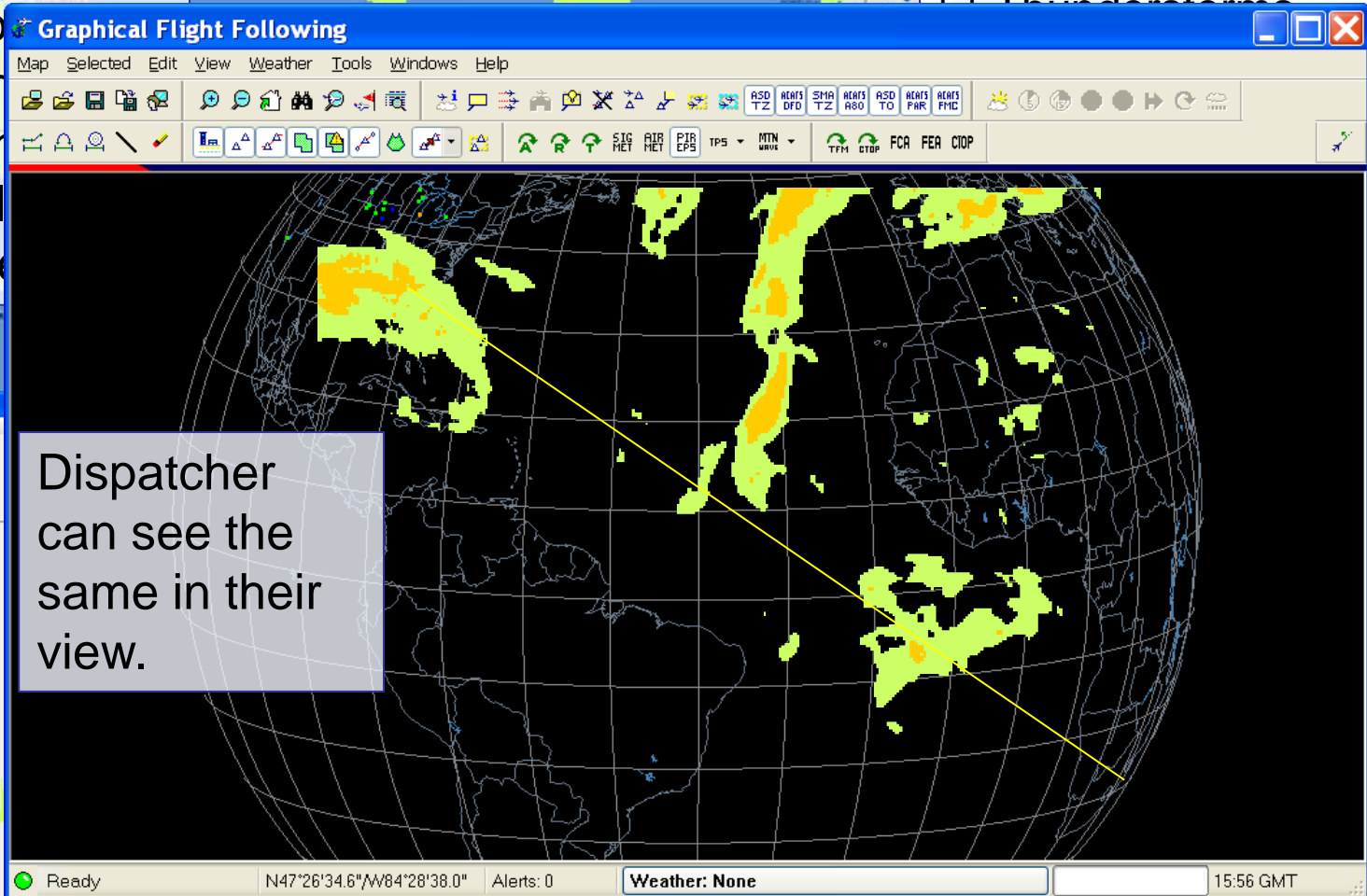
Moderate or greater

# Step 3: Flight Specific Graphics

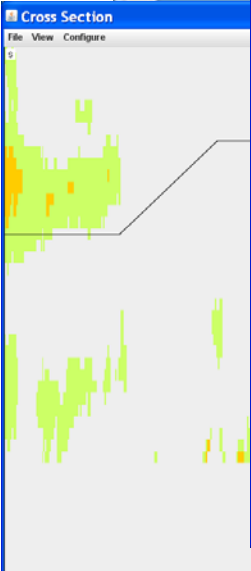
Pilot can enter the flight number and see path along with hazards in horizontal and vertical view

## Overlay Options:

- TP's
- Thunderstorms



Dispatcher can see the same in their view.



# Turbulence Forecast Challenges



# Process 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



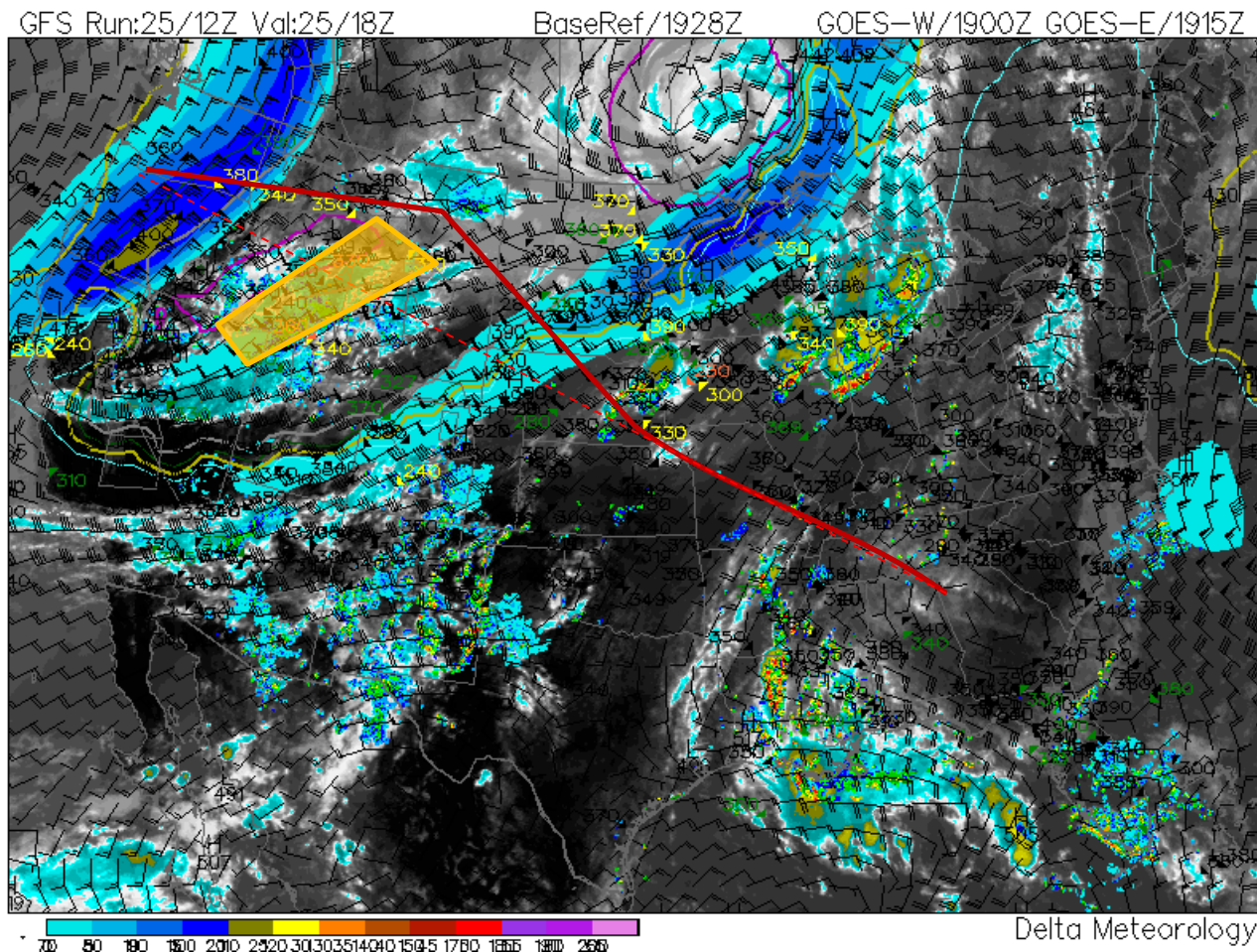
# Turbulence Forecasting Challenges

- 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



# Human Factor Challenges

## Managing data displays to highlight significant operational impacts





# Model & Human Produced Forecasts

## Delta's Goals

- 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?**