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The General Aviation Pilot Preflight Weather Planning: Weather Products Usability & Limitations

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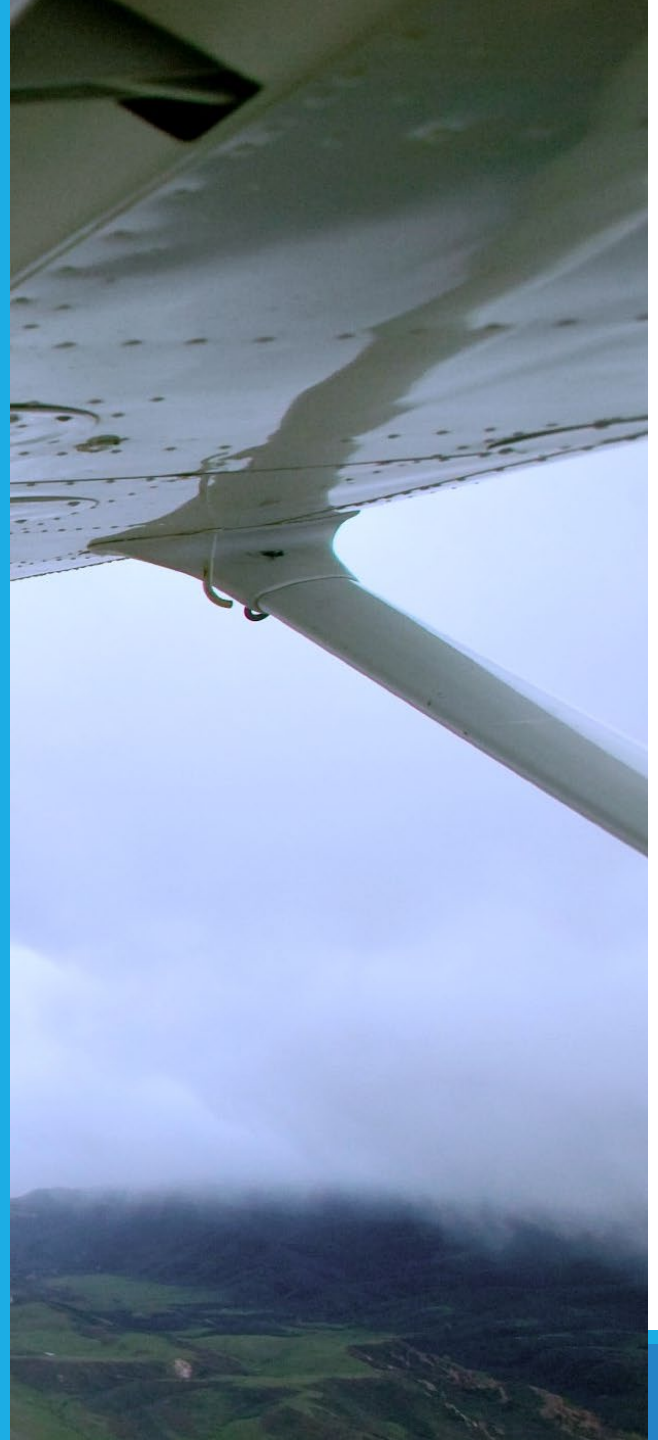
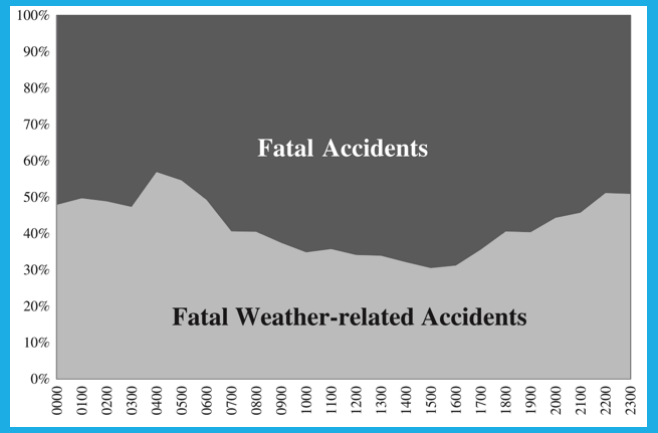


PART 01 **Background**

Over the last 30 years, a large percentage of weather- related aviation accidents have occurred under General Aviation (GA) operations (FAA, 2010; Fultz & Ashley, 2016; AOPA, 2008).

- Novice Private Pilots VFR into IMC
- High Risk For Incurring Fatality



(Fultz & Ashley, 2016).

PART 02

Aviation Weather Challenges

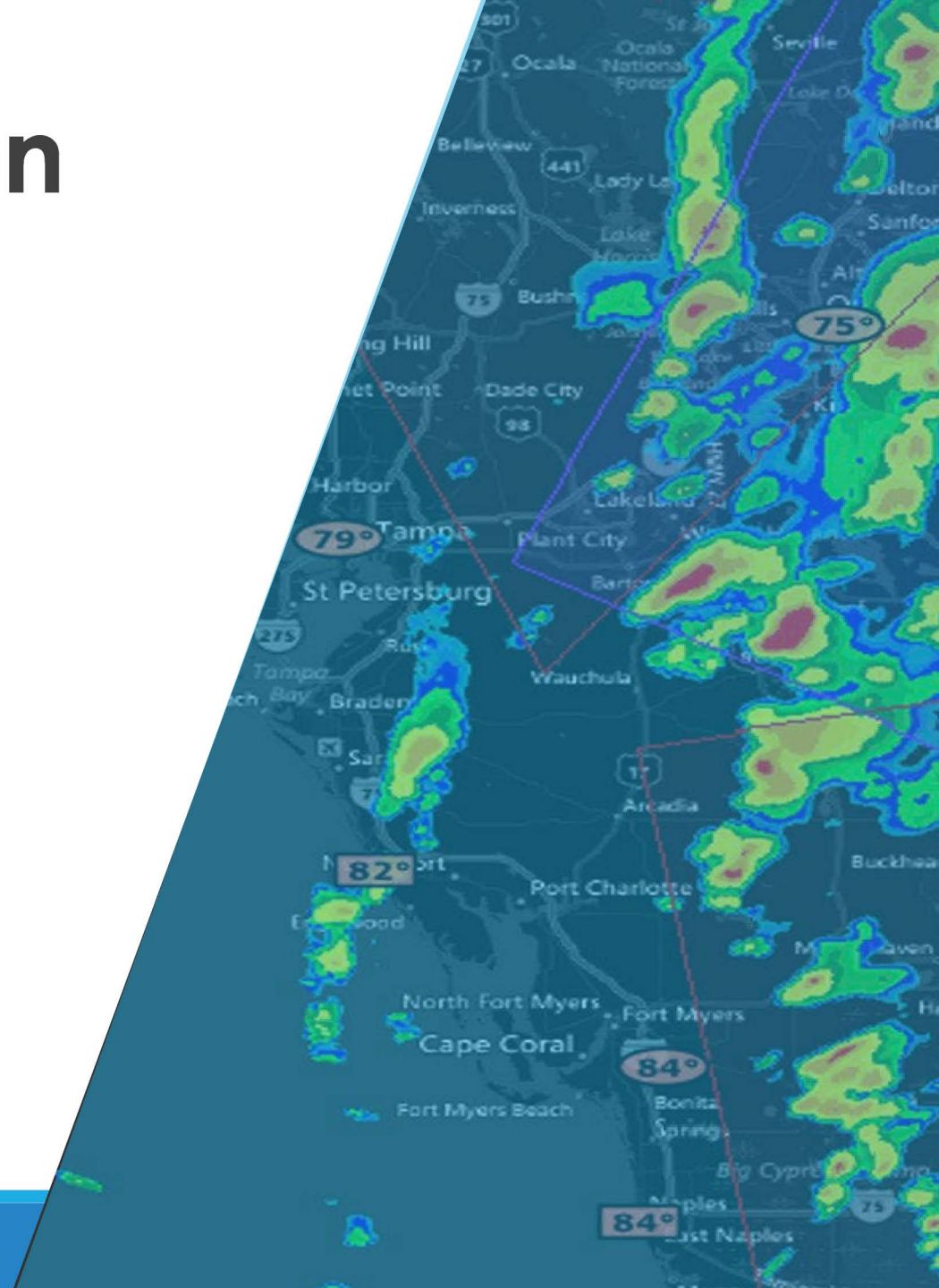
1. Difficult to Interpret Aviation Weather Products

2. Pilot's Decision Making Biases and Errors

3. GA Pilots' Lack of Aviation Weather Experience

Difficult to Interpret Aviation Weather Products

- Weather products are crucial for preflight planning
- Poor usability weather products
- Inexperienced GA Pilots' Lack of Aviation Weather Experience



Pilots struggle with Aviation Weather Preflight Tasks

Low experienced pilots may be incurring weather-related accidents due to their inability to:

- Access
- Interpret
- Apply

weather information (Blickensderfer et al., 2018).

New Weather Product Displays

- Aviation Weather Center (AWC) & Federal Aviation Administration (FAA) produce graphical and interactive weather products

- Improved products may be more confusing than helpful

(Latorella & Chamberlain, 2002; Yuchnovicz et al., 2001; Beringer and Ball, 2004).

Purpose

- Compare the usability of AWC and Foreflight weather information and displays.
- Highlight how weather product displays on AWC and Foreflight can hinder or assist with preflight planning processes.
  - Perceive
  - Process
  - Perform

Aviation Weather Knowledge Assessment

Blickensderfer et al. (2018) developed an aviation weather exam to evaluate GA pilots' ability to interpret :

- Observation
- Analysis
- Forecast

Results indicated that, pilots' product interpretation scores were quite low.

Assessment of Interpretability of Weather Products: Phase 1

General Aviation Pilots scored the lowest on the following weather products:

Forecast
- G-AIRMET
- NCWF
- TAF

Observation
- METAR
- Satellite

Product Type	n	Total M (SD)
Satellite	204	54.04 (27.78)
METAR	204	46.14 (20.23)
TAF	204	50.00 (25.84)
G-AIRMET	204	48.82 (20.72)
NCWF	204	45.59 (28.79)

Table 2. Effect of Pilot Rating and Forecast Type on Interpretation Score. (Blick et al., 2018)

Assessment of Interpretability of Weather Products: Phase 2

General Aviation Pilots scored the lowest on the following weather products:

- METARS
- TAF
- Radar
- Satellite

Product Type	n	Total M (SD)
Satellite	176	58.1 (29.4)
Radar	198	60.7 (17.7)
TAF	149	56.9 (24.8)
METAR	149	54.5 (19.0)

(Blick et al., 2018)

Usability Principles

Usability and human centered design can assist with :

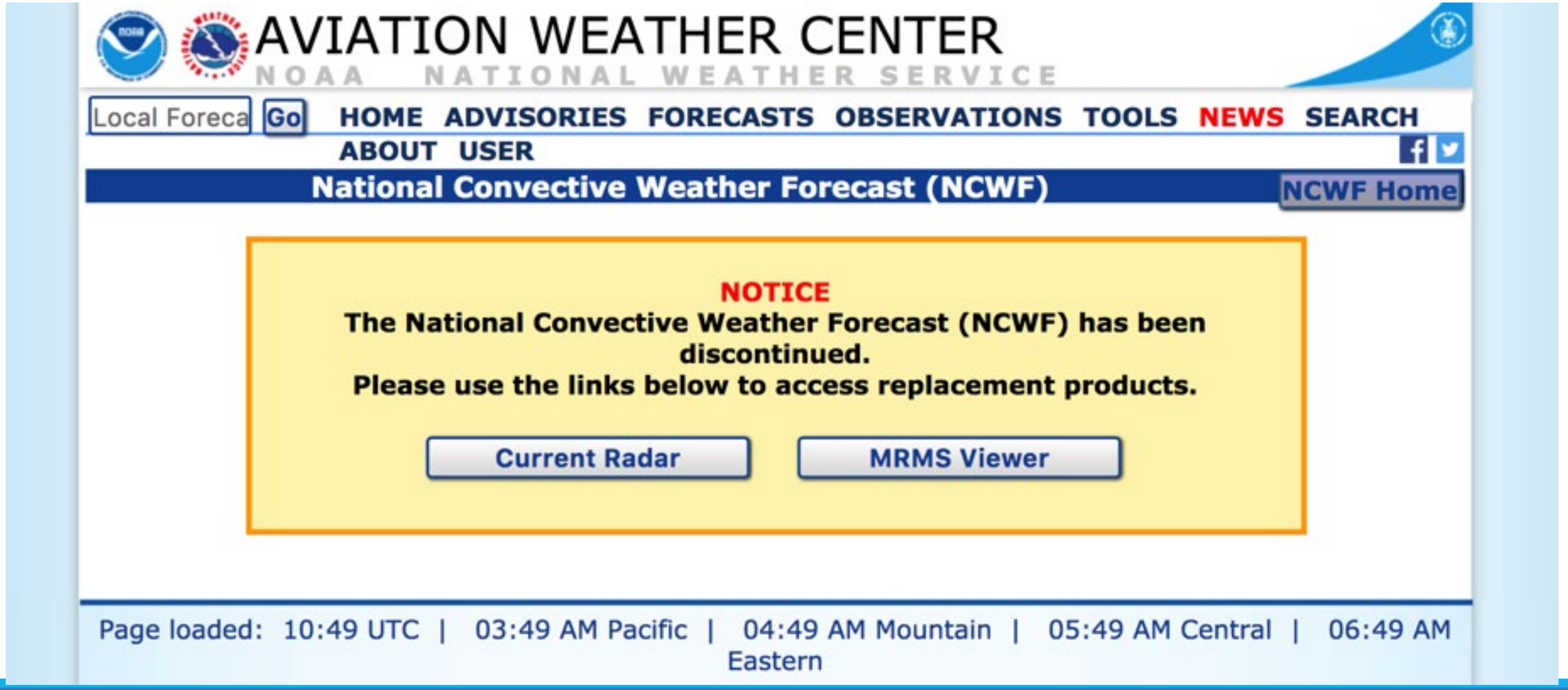
- Interpretability
- Product and System Transparency

Poor usability may actually encourage hazardous behavior rather than prevent it.

- i.e Radar

(Latorella & Chamberlain, 2002; Yuchnovicz et al., 2001; Beringer and Ball, 2004)

NCWF


AVIATION WEATHER CENTER
NOAA NATIONAL WEATHER SERVICE
Local Foreca
Go
HOME ADVISORIES FORECASTS OBSERVATIONS TOOLS NEWS SEARCH
ABOUT USER
National Convective Weather Forecast (NCWF)
NCWF Home
NOTICE
The National Convective Weather Forecast (NCWF) has been discontinued.
Please use the links below to access replacement products.
Current Radar
MRMS Viewer
Page loaded: 10:49 UTC | 03:49 AM Pacific | 04:49 AM Mountain | 05:49 AM Central | 06:49 AM Eastern

MRMS
multi-radar multi-sensor

Operational Product Viewer

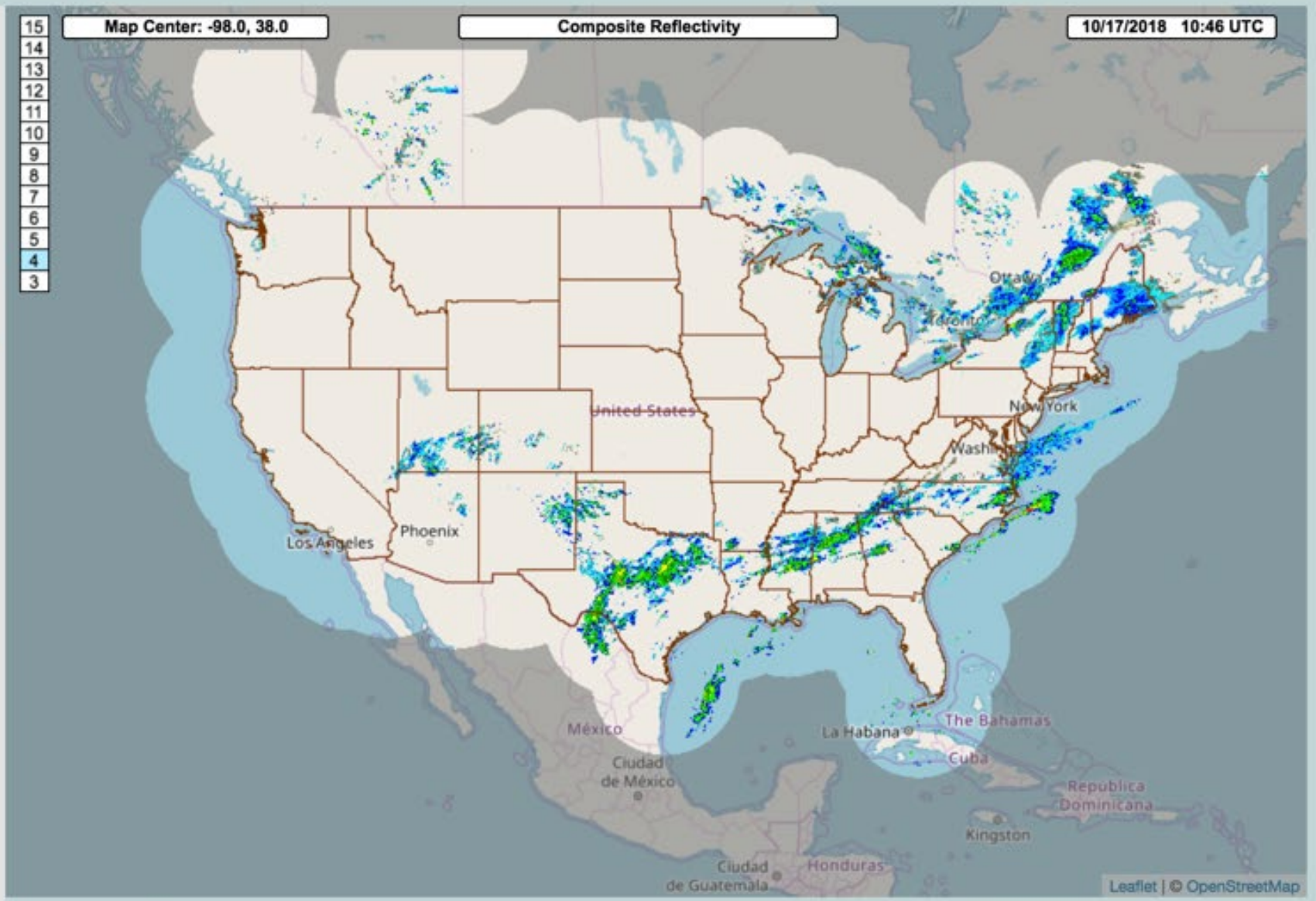
2018	Oct	17	10:46	UTC	2 min ▶
:00	:02	:04	:06	:08	:10	4 min
:12	:14	:16	:18	:20	:22	10 min
:24	:26	:28	:30	:32	:34	30 min
:36	:38	:40	:42	:44	:46	1 hr
:48	:50	:52	:54	:56	:58	6 hr
						1 dy

Current Time Auto Update

Product Type

- Base Reflectivity
- Composite Reflectivity
- Seamless Hybrid Scan
- Refl At Lowest Altitude
- Layer Reflectivity
- Echo Top
- Layer Thickness
- 3D Mosaic Levels
- Radar Quality Index
- Rotation
- Hail
- Lightning
- Gauge Influence Index
- FLASH
- Q3 Radar Only
- Q3 Gauge Only
- Q3 Gauge Corrected Rad
- Q3 Mountain Mapper
- Vertically Integrated Water
- Bright Band
- Precipitation Flag
- AutoNowCaster

CREF
Max Method
1 hr Max
Un-QC'ed
Height



Loop Image Reset Region mPING Legend Overlays

Opacity 0% 100% Enable Mouse Wheel mPING Reports None Base Map Layer

METAR & TAF

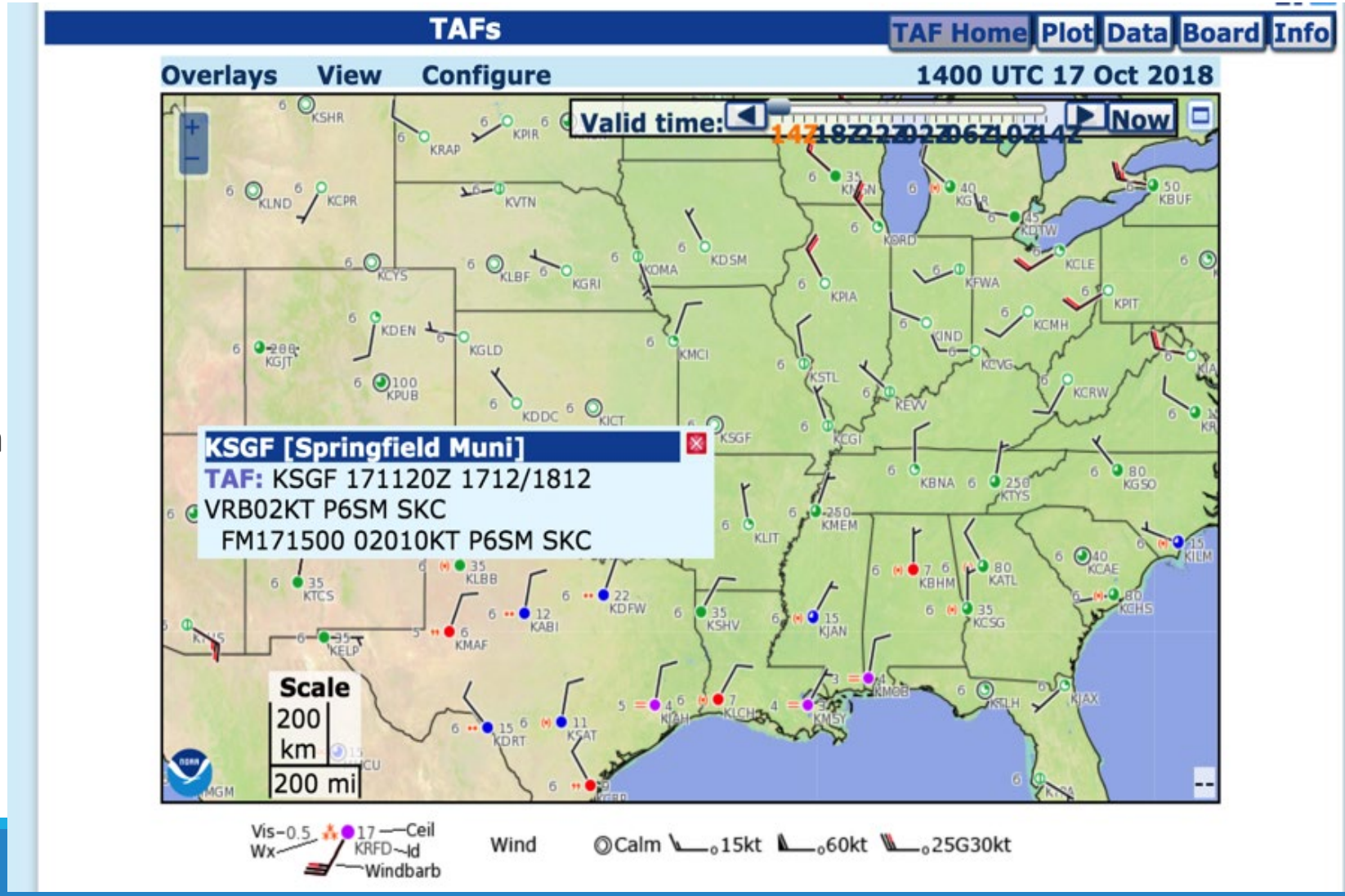
Aviation Weather Center

Pros:

- Issuance times
- Decoded option

Cons:

- Does not provide color coding based on interpretation (vfr/mvfr/ ifr)
- Does not recommend METARS to check



METAR & TAF

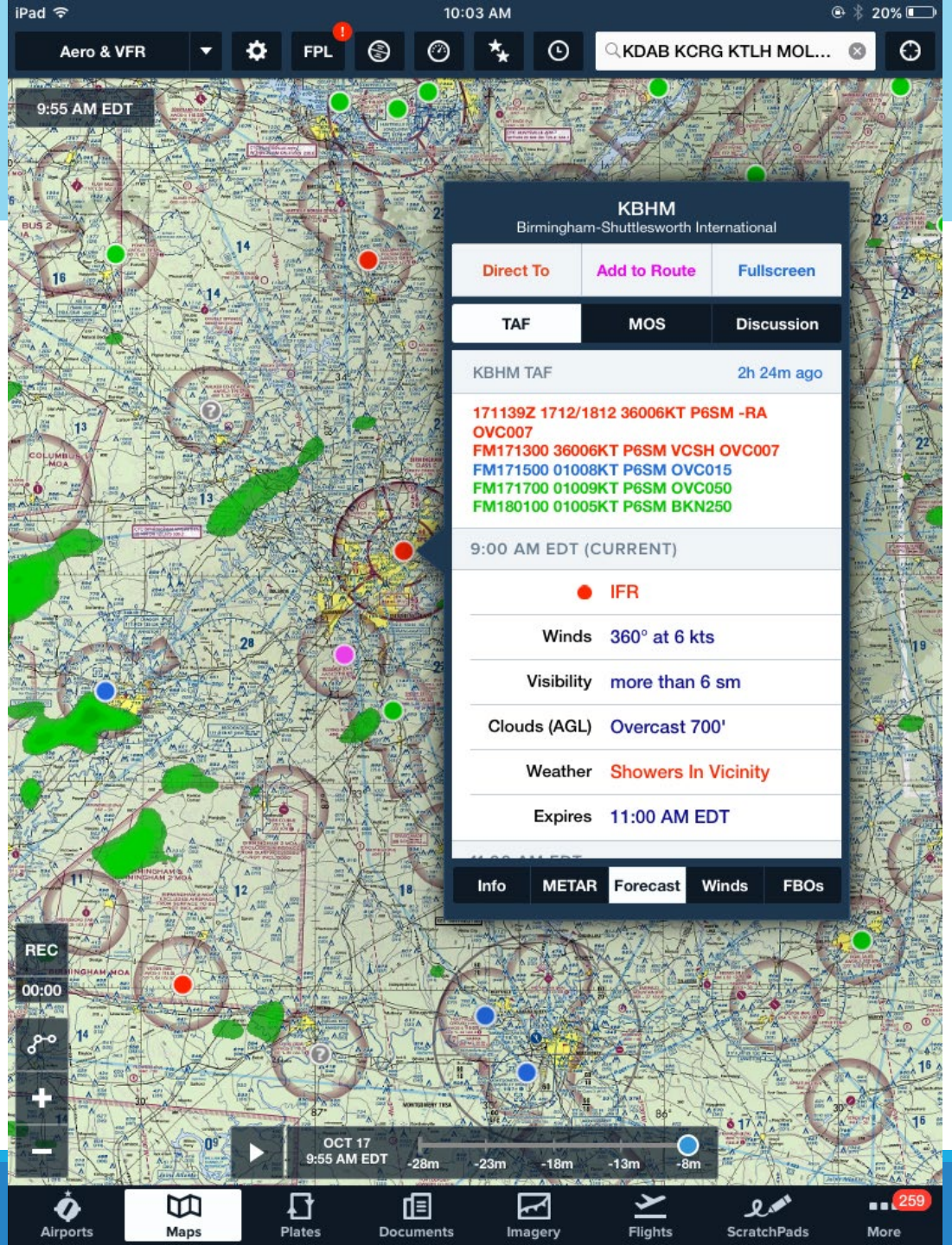
Foreflight

Pros:

- Issuance times
- Multiple times before the requested METAR for trending
- Color Coded (VFR/MVFR/IFR)
- Recommended METARS along the flight route
- Provides graphical depiction of METARS

Cons:

- Does not provide the option for including TAFs with the METARs



G-AIRMET

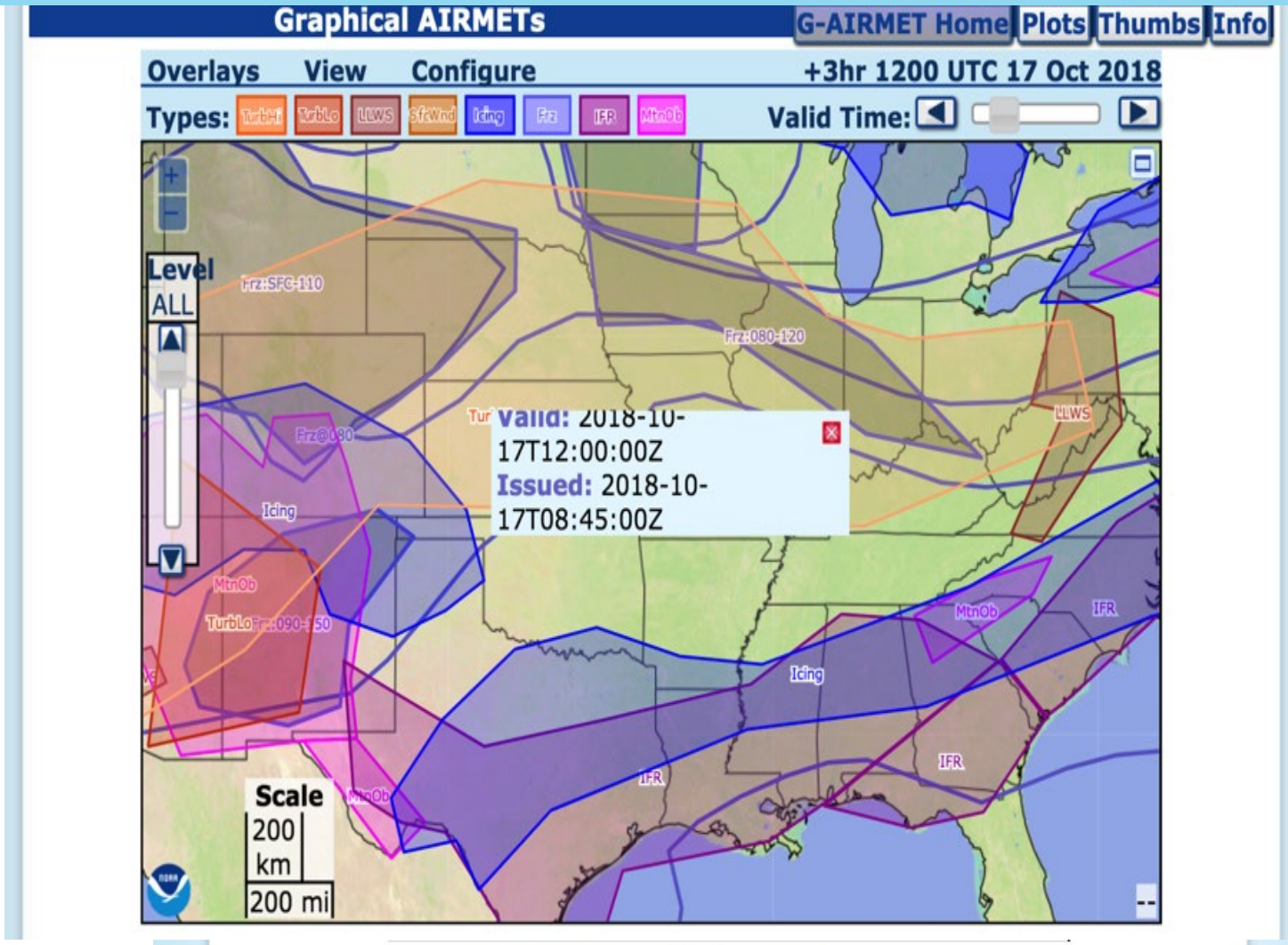
Aviation Weather Center

Pros:

- Features Legend
- Allows users to easily transition between different time stamped G-AIRMET Products
- Allows users to overlay different G-AIRMET types

Cons:

- Confusing issuance times
- Ambiguity on the criteria for the weather phenomena to be reported is
- Does not include reference to the users flight route or location



G-AIRMET

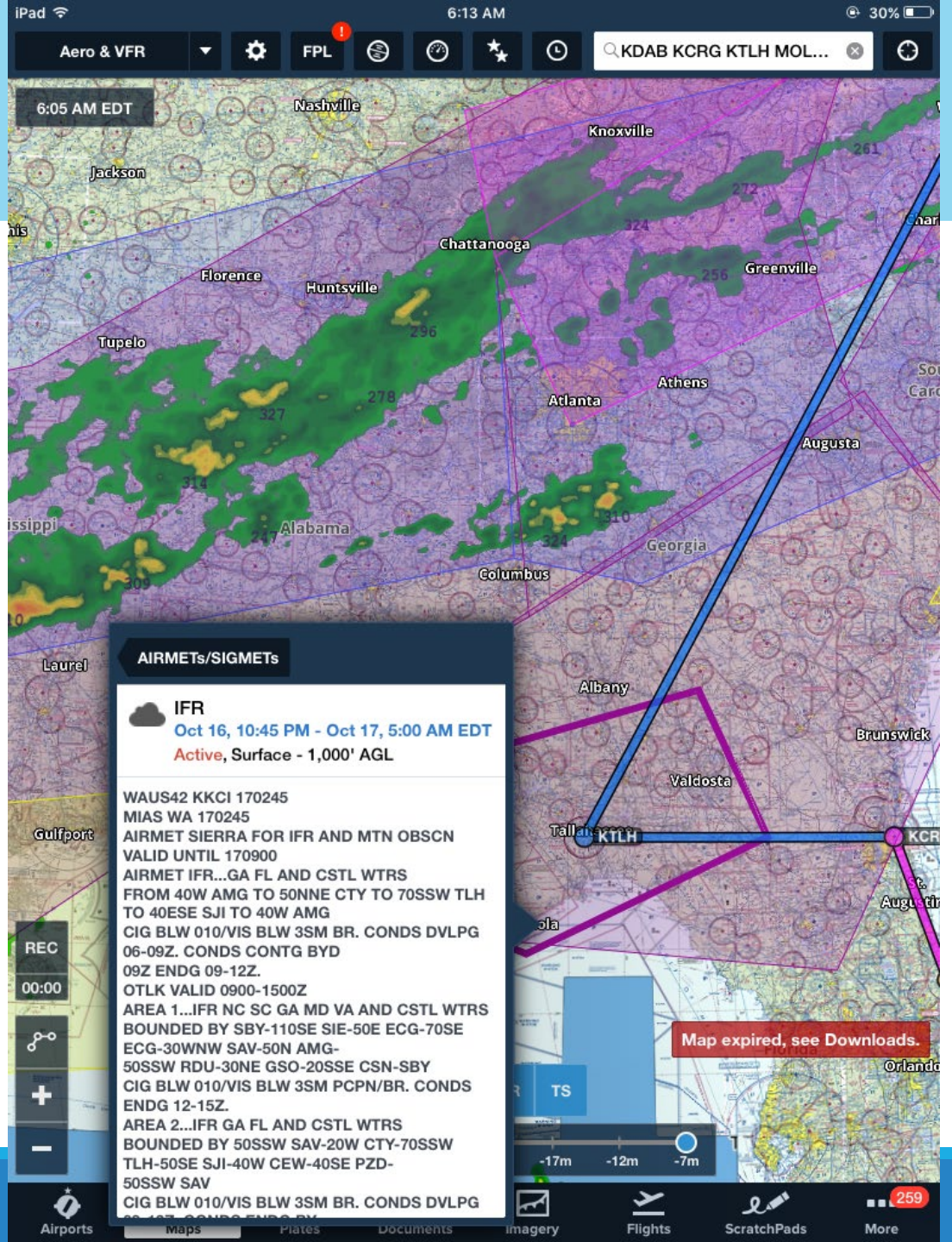
Foreflight

Pros:

- Displays the G-AIRMET in plain text
- Allows users to easily transition between different time stamped G-AIRMET Products
- Allows users to overlay different G-AIRMET TYPES, satellite, radar
- Makes the issuance times easy to understand

Cons:

- Does not feature legend
- Ambiguity on what the criteria for the reported weather phenomena



Satellite

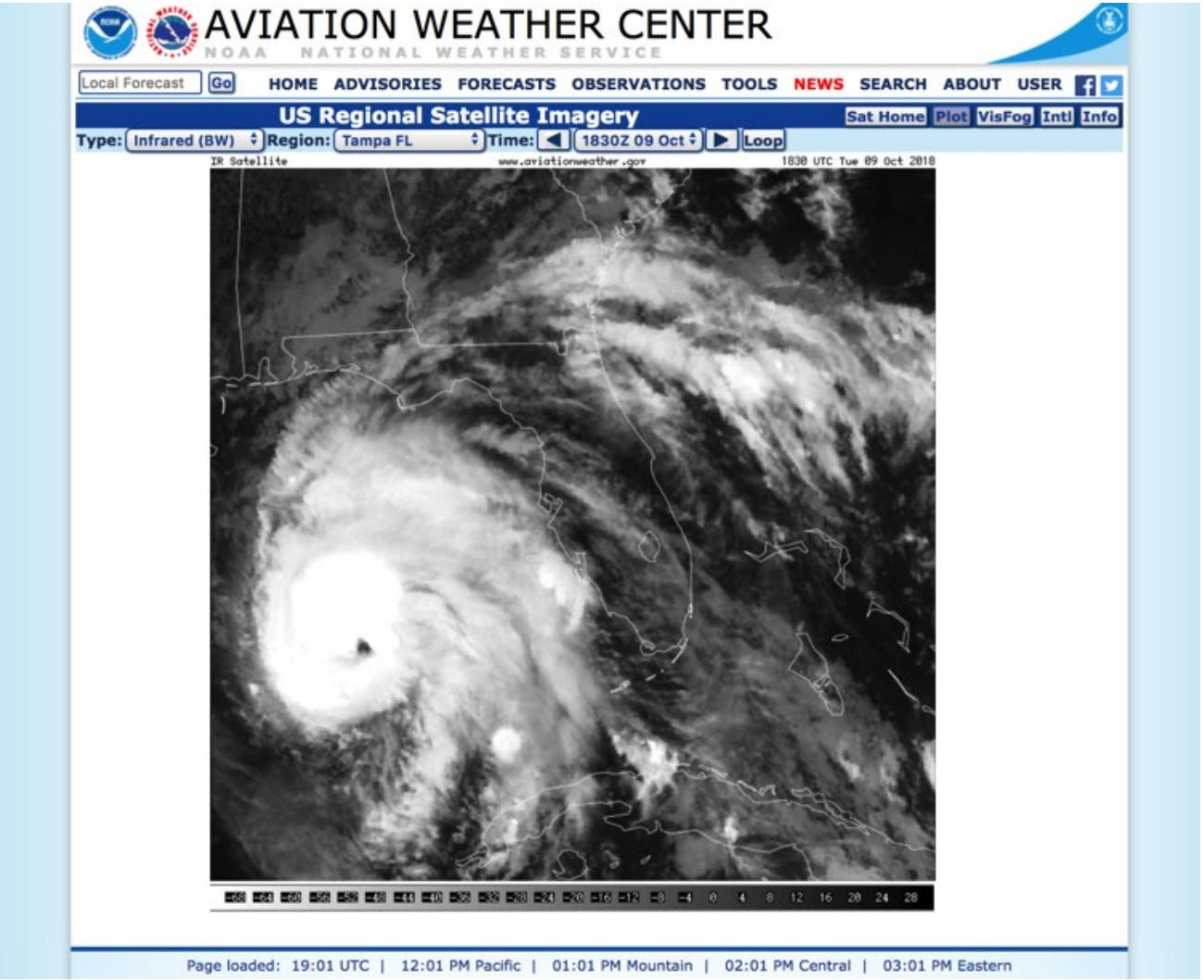
Aviation Weather Center

Pros:

- Allows users to overlay different Satellite types, regions, and times

Cons:

- Features legend that is difficult to link the weather phenomena
- Does not indicate cloud height
- Does not easily display valid times and issuance times



Satellite

Aviation Weather Center

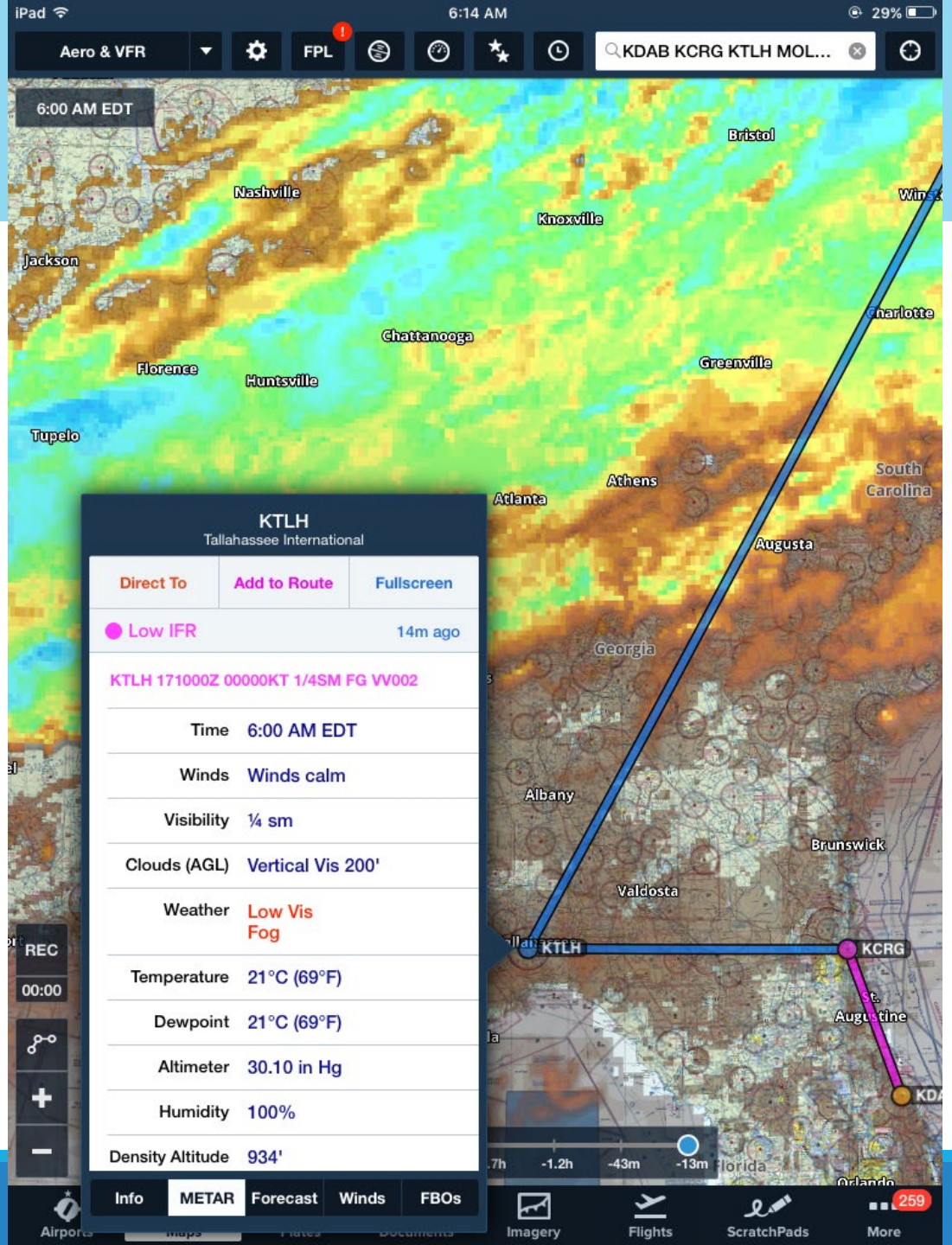
Foreflight

Pros:

- Allows users to over lay satellite data over various map types such as aeronautical sectional charts
- Also allows users to overlay METAR & TAF information on the display
- Allows users to access different Satellite types, regions, and times

Cons:

- Features legend that is difficult to link the weather phenomena
- Does not indicate cloud height
- Does not easily display valid times and issuance times



Radar

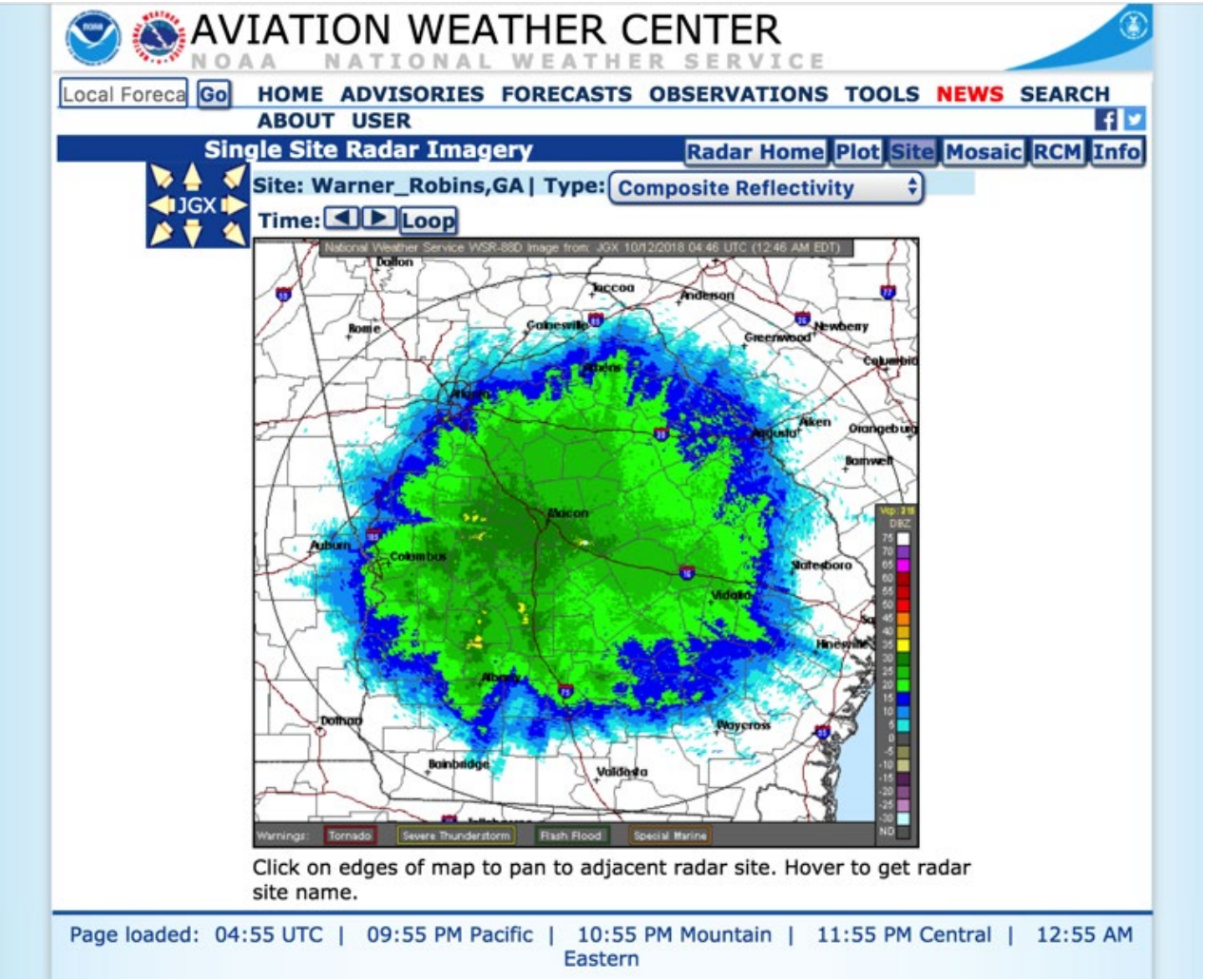
Aviation Weather Center

Pros:

- Features a limited legend without all the symbols from the weather product.
- Allows users to switch between different types of reflectivity and regions

Cons:

- Does not easily display valid times and issuance times
- Does not display a legend that easily relates to the reported weather phenomena



Radar

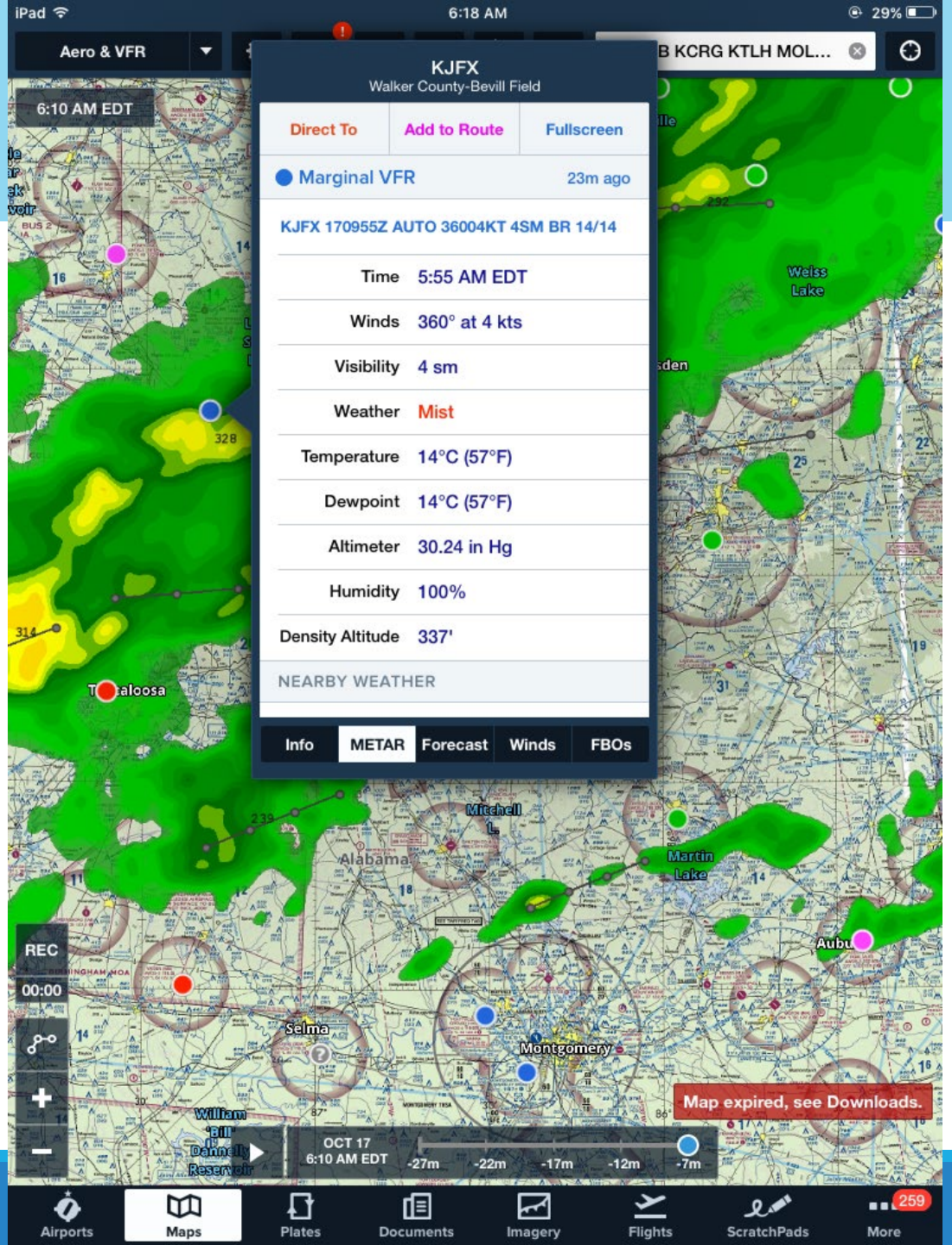
Foreflight

Pros:

- Allows users to switch between different types of reflectivity and regions
- Allows users to overlay radar over the aeronautical sectional chart

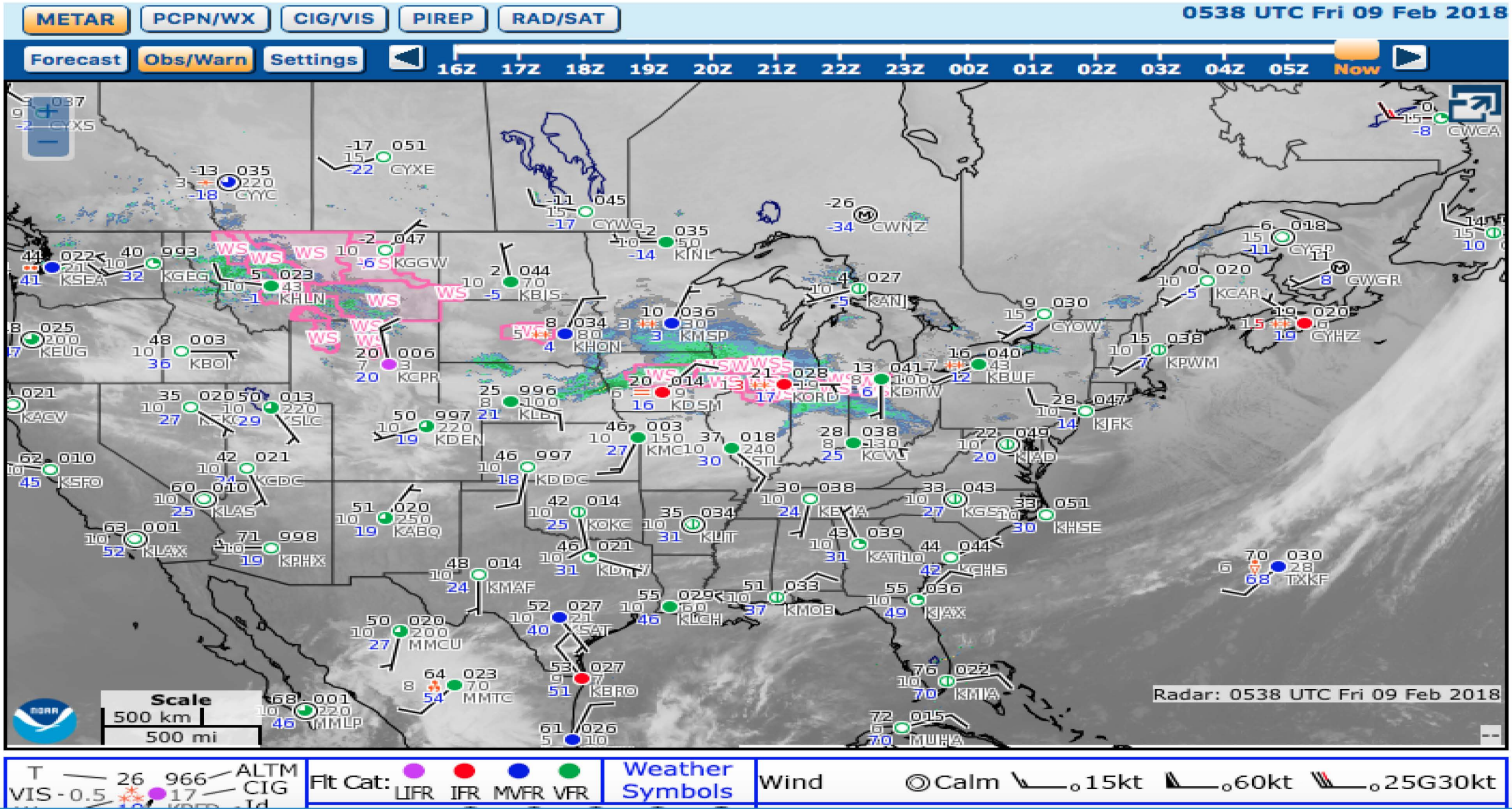
Cons:

- Does not easily display valid times and issuance times
- Does not display a legend that easily relates to the weather phenomena that relates the the legend



Graphical Forecast for Aviation (GFA)

- New, Web-based weather display
  - Covers the continental U.S., ground up to 42,000 feet
  - Observations (current weather data)
  - Forecasts
  - Updated hourly
- **Three major components:**
  - Satellite (low ceiling and visibility)
  - Radar (presence of precipitation)
  - Station Plots (symbols used to represent wind speed, rain and other precipitation)


METAR
PCPN/WX
CIG/VIS
PIREP
RAD/SAT
0538 UTC Fri 09 Feb 2018
Forecast
Obs/Warn
Settings
16Z 17Z 18Z 19Z 20Z 21Z 22Z 23Z 00Z 01Z 02Z 03Z 04Z 05Z Now
Scale
500 km
500 mi
Radar: 0538 UTC Fri 09 Feb 2018
T
VIS - 0.5
ALTM
CIG
Id
Flt Cat:
LIFR
IFR
MVFR
VFR
Weather Symbols
Wind
Calm
15kt
60kt
25G30kt

Results - Mean Percentage Correct

	Radar M(SD)	Station Plots M(SD)	Satellite M(SD)
Private	54.01 (17.11)	36.30 (22.83)	56.83 (26.81)
Private w. Instrument	60.82 (18.63)	35.77 (21.59)	64.81 (28.05)
Commercial w. Instrument	67.22 (15.15)	43.68 (22.89)	59.61 (28.33)
CFI/CFII	67.06 (19.27)	50.00 (22.92)	55.36 (30.36)
Total	60.53 (18.22)	39.44 (22.67)	59.76 (27.89)

- 3 separate 2x4 ANOVAs were conducted to compare the effect of Product and Pilot Certificate/Rating on the Interpretation score
  - Station Plots and Satellite
  - Radar and Satellite
  - Radar and Station Plot
- Scores were quite low!

Results – Station Plots and Satellite

	Radar M(SD)	Station Plots M(SD)	Satellite M(SD)
Private	54.01 (17.11)	36.30 (22.83)	56.83 (26.81)
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Total	60.53 (18.22)	39.44 (22.67)	59.76 (27.89)

- Mixed between and within-subjects ANOVA was conducted to assess impact of Product type and Pilot Certificate/Rating on scores
  - No interaction between Product type and Pilot Certificate/Rating
  - Main Effect for Product, partial eta squared = 0.21
- *Suggests that pilots interpret Satellite products better than Station Plot*

Results – Radar and Satellite

	Radar M(SD)	Station Plots M(SD)	Satellite M(SD)
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Private w. Instrument	60.82 (18.63)	35.77 (21.59)	64.81 (28.05)
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CFI/CFII	67.06 (19.27)	50.00 (22.92)	55.36 (30.36)
Total	60.53 (18.22)	39.44 (22.67)	59.76 (27.89)

- Two-way between groups ANOVA was conducted to assess impact of Product type and Pilot Certificate/Rating on scores.
  - No interaction between Product type and Certification and/or Rating
  - No Main Effects for Product OR Rating
- *Pilots interpreted Satellite and Radar at about the same level regardless of skill level.*

Results – Radar and Station Plots

	Radar M (SD)	Station Plots M (SD)	Satellite M (SD)
Private	54.01 (17.11)	36.30 (22.83)	56.83 (26.81)
Private w. Instrument	60.82 (18.63)	35.77 (21.59)	64.81 (28.05)
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Total	60.53 (18.22)	39.44 (22.67)	59.76 (27.89)

- Two-way between groups ANOVA was conducted to assess impact of Product type and Pilot Certificate/Rating on scores.
  - No interaction between Product type and Certificate/Rating
  - Significant Main Effect for Product on score, Partial Eta Squared = .194
  - Significant Main Effect for Certificate/Rating on score, Partial Eta Squared. = .06
- *Pilots interpreted Radar better than Station Plots*

Discussion

- A major contributing factor in the weather accidents may be Pilots' inability to interpret weather displays.
- New technology is *reusing* existing display formats and symbology that *Pilots may not understand*
- The products are not discriminating: Pilots of ALL ratings and certificates are struggling
- Improving usability could help with product interpretability


Questions?

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