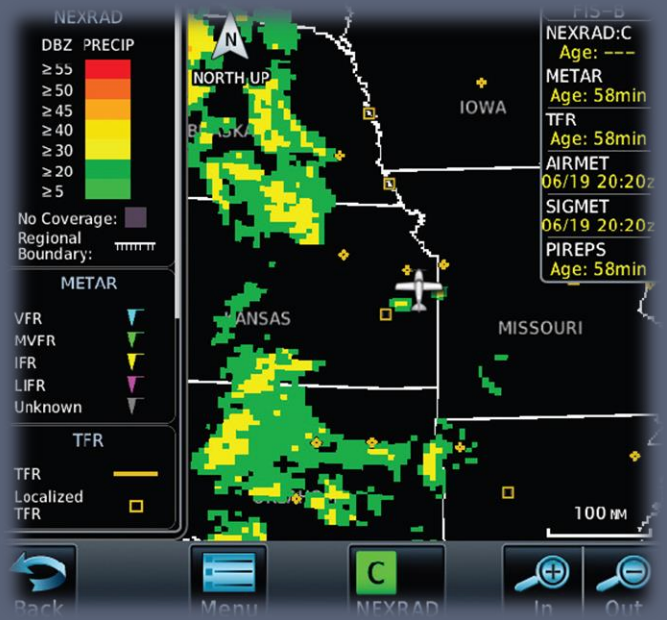


Effectively Using ADS-B

How to best utilize cockpit weather and traffic

Presentation Outline

- ADS-B Overview
  - Traffic (TIS-B)
  - Weather (FIS-B)
  - Coverage Maps
- Spherics
  - Overview
  - Operating Modes
- Datalink Traffic
  - Benefits & Limitations
  - Tips
- Break
- Datalink Weather
  - Benefits & Limitations
  - Weather Radar Basics
  - Tips
- Real-World Examples
  - VFR Summer
  - VFR Winter
  - IFR Summer
  - IFR Winter

ADS-B Overview

How the system works, in brief

Automatic Dependent Surveillance - Broadcast

- What is ADS-B?
  - The automatic broadcast of position reports by aircraft, surface vehicles, and transmitters on fixed objects.
  - Data includes: identity (flight ID, call sign, tail number, etc), ground track, ground speed, pressure altitude, emergency status, aircraft/equipment capabilities.
- Breaking it down
  - Automatic – The system works without any user intervention
  - Dependent – The system depends on an accurate position source (GPS WAAS)
  - Surveillance – The system is intended to replace/augment traffic reporting systems (RADAR)
  - Broadcast – ADS-B participants actively broadcast their data, rather than waiting for an interrogation

Two types of ADS-B

978 UAT

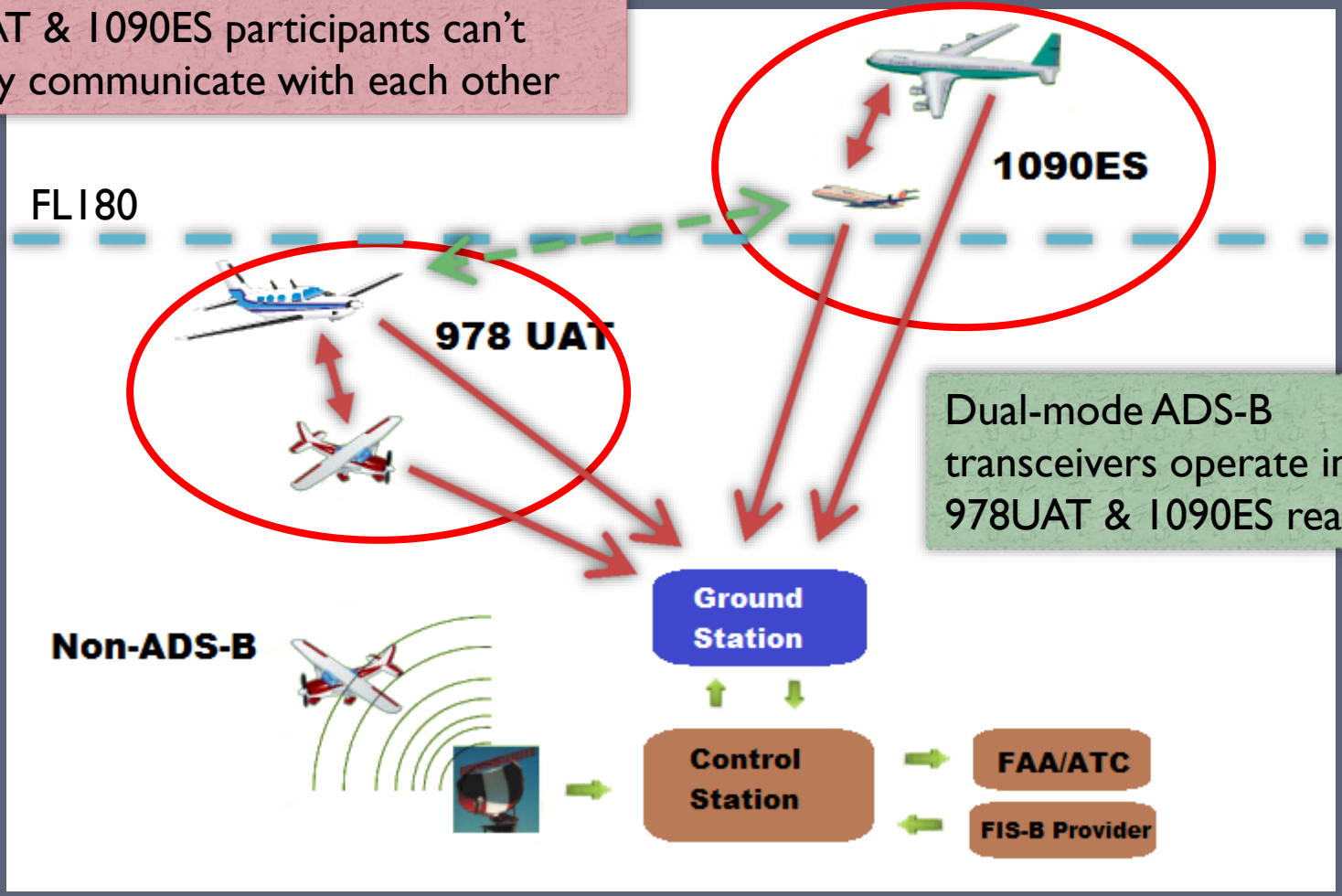
- 978Mhz primary frequency
- UAT = "Universal Access Transceiver"
- Discrete frequency to reduce congestion on 1090Mhz
- Used for traffic reporting and flight information services
- U.S. only (below FL180)

1090ES

- 1090Mhz primary frequency
- ES = "Extended Squitter"
- Works on the same basic frequency as 4096-code transponders
- Only used for traffic reporting
- U.S. and internationally

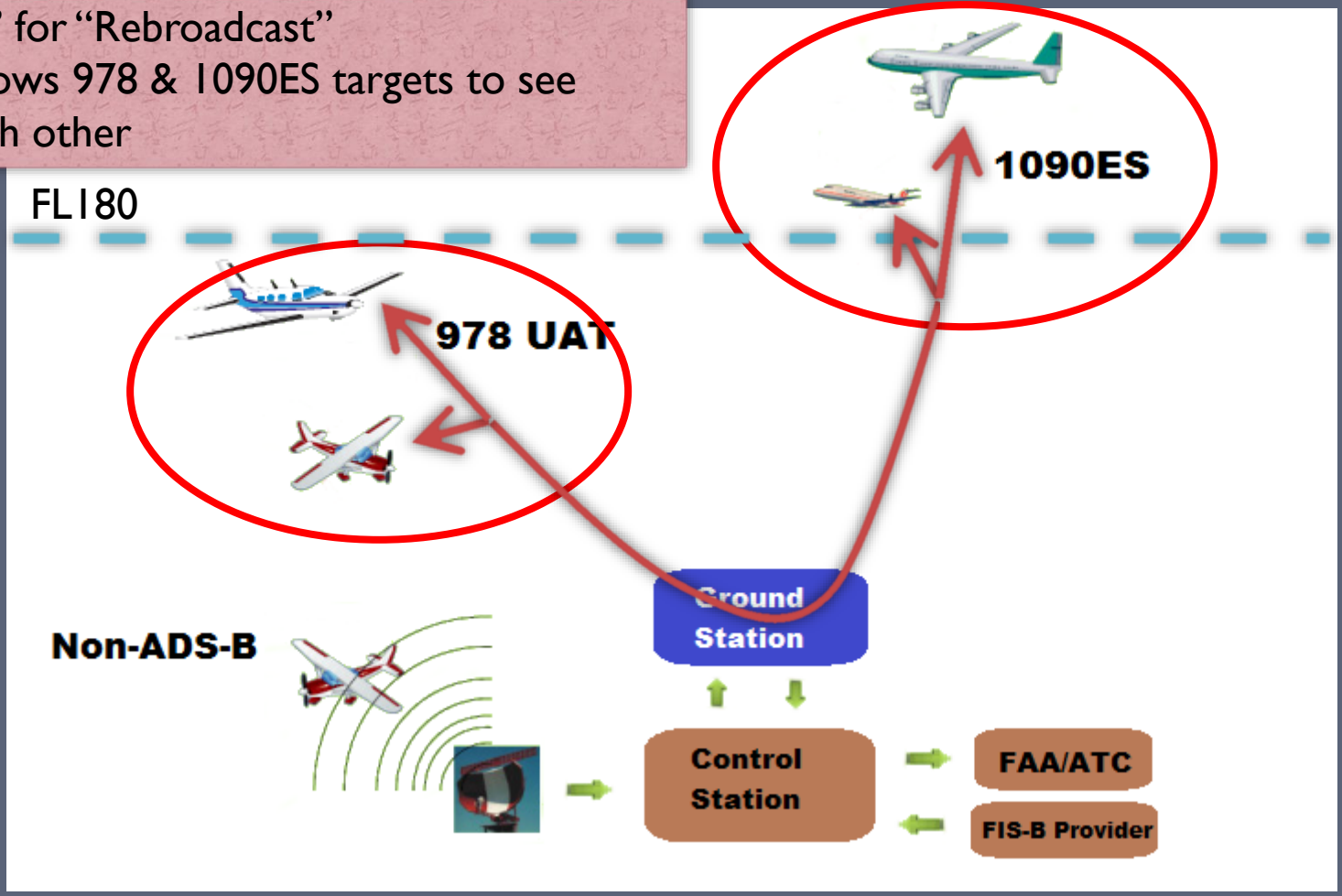
ADS-B Overview

978UAT & 1090ES participants can't directly communicate with each other



ADS-R

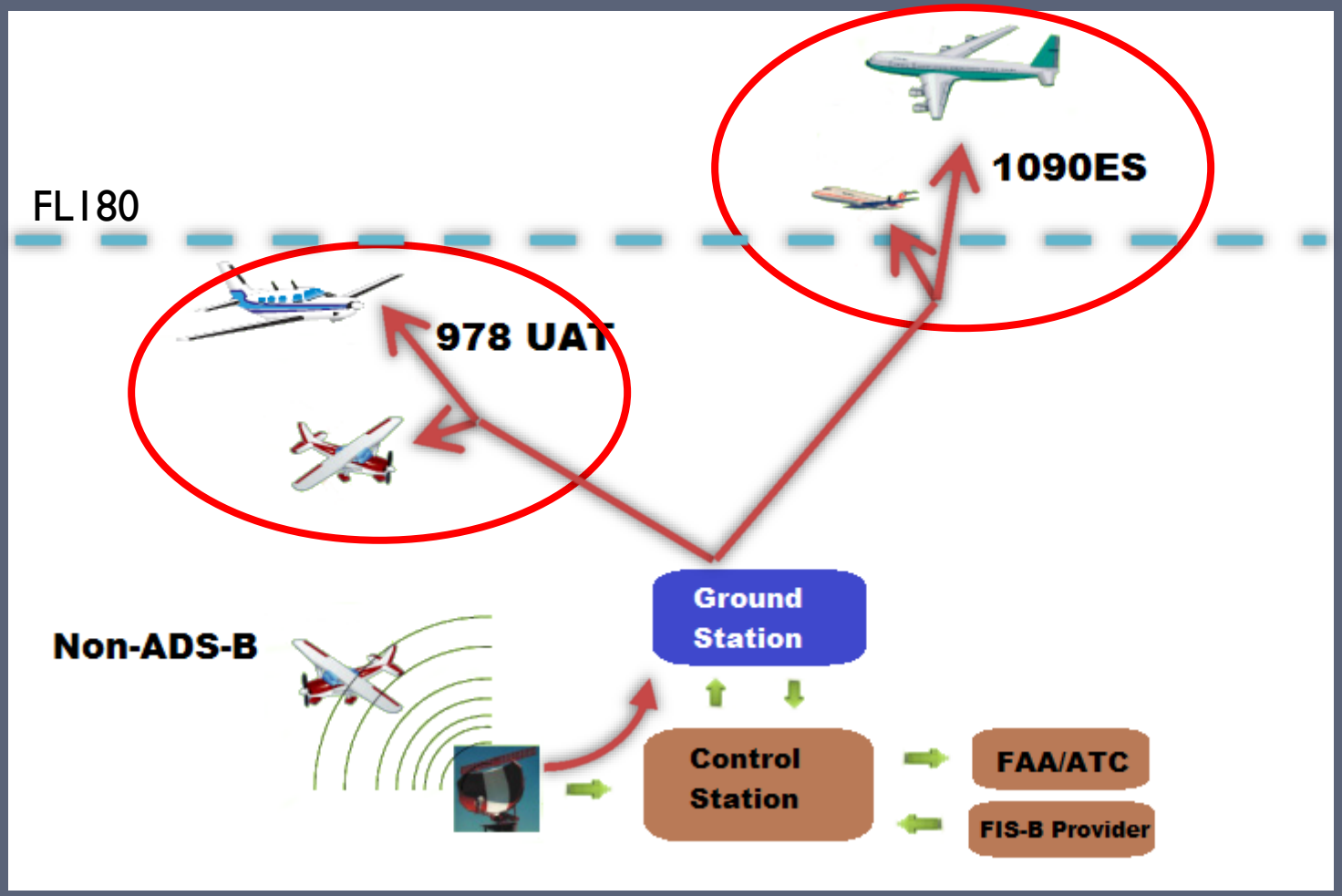
- "R" for "Rebroadcast"
- Allows 978 & 1090ES targets to see each other



Traffic Information Services - Broadcast

- TIS-B: Provides a bridge between non-ADS-B participants and ADS-B participants
  - ATC radar tracks targets for TIS-B upload within +/- 3,500 feet and 15nm of ADS-B participants
  - Aircraft with ADS-B In receivers but no ADS-B Out transmitters can "piggyback" on this data, but are at the mercy of ADS-B Out aircraft in the vicinity
- TIS-B data is broadcast every 2-12 seconds, depending on the characteristics of the ground radar station
  - Only traffic within radar coverage will be visible
- For informational purposes only!
  - TIS-B data should not be used in lieu of proper see-and-avoid techniques; it does not satisfy the requirements of 14 CFR 91.113(b) [right-of-way/see-and-avoid]

TIS-B


FL180
1090ES
978 UAT
Non-ADS-B
Ground Station
Control Station
FAA/ATC
FIS-B Provider

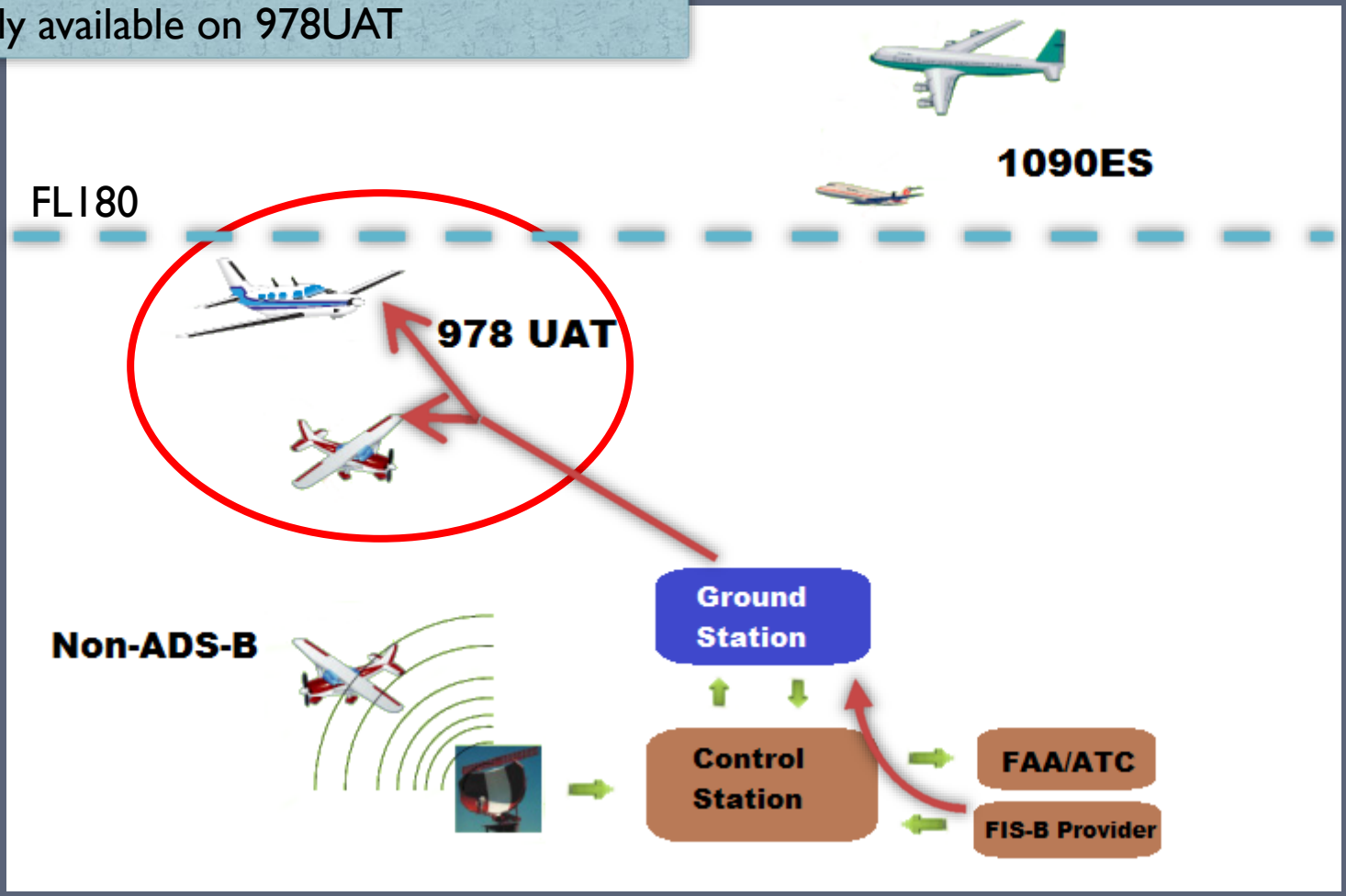
Flight Information Services - Broadcast

- FIS-B: Provides weather and pilot information for enhanced situational awareness
- Data is broadcast continuously, and available on any 978UAT ADS-B In receiver
  - Not available over 1090ES

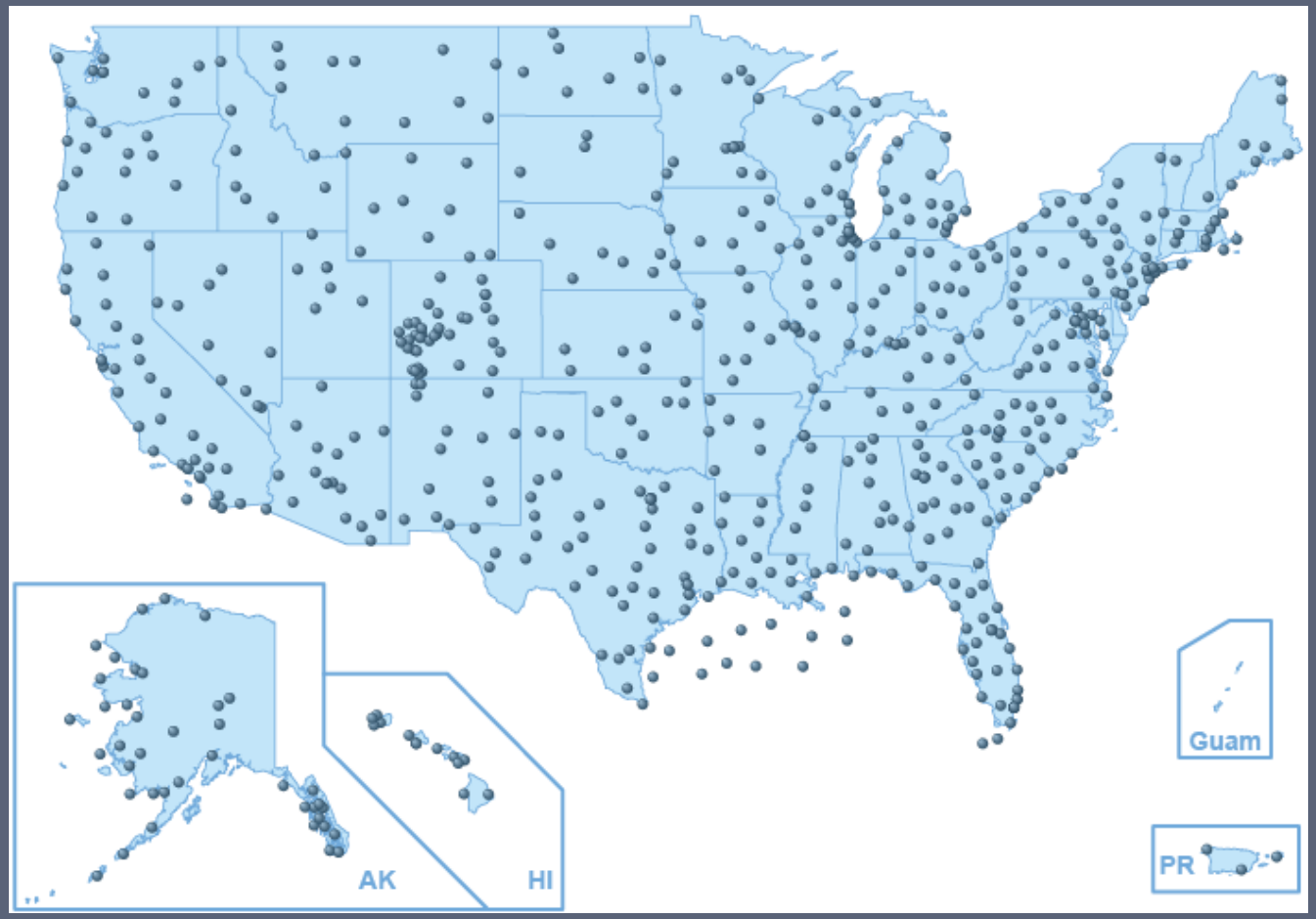
- For informational purposes only!
  - FIS-B data should not be used in lieu of a proper preflight briefing; it does not satisfy the requirements of 14 CFR 91.103(a) [preflight weather briefing]

FIS-B

- Only available on 978UAT

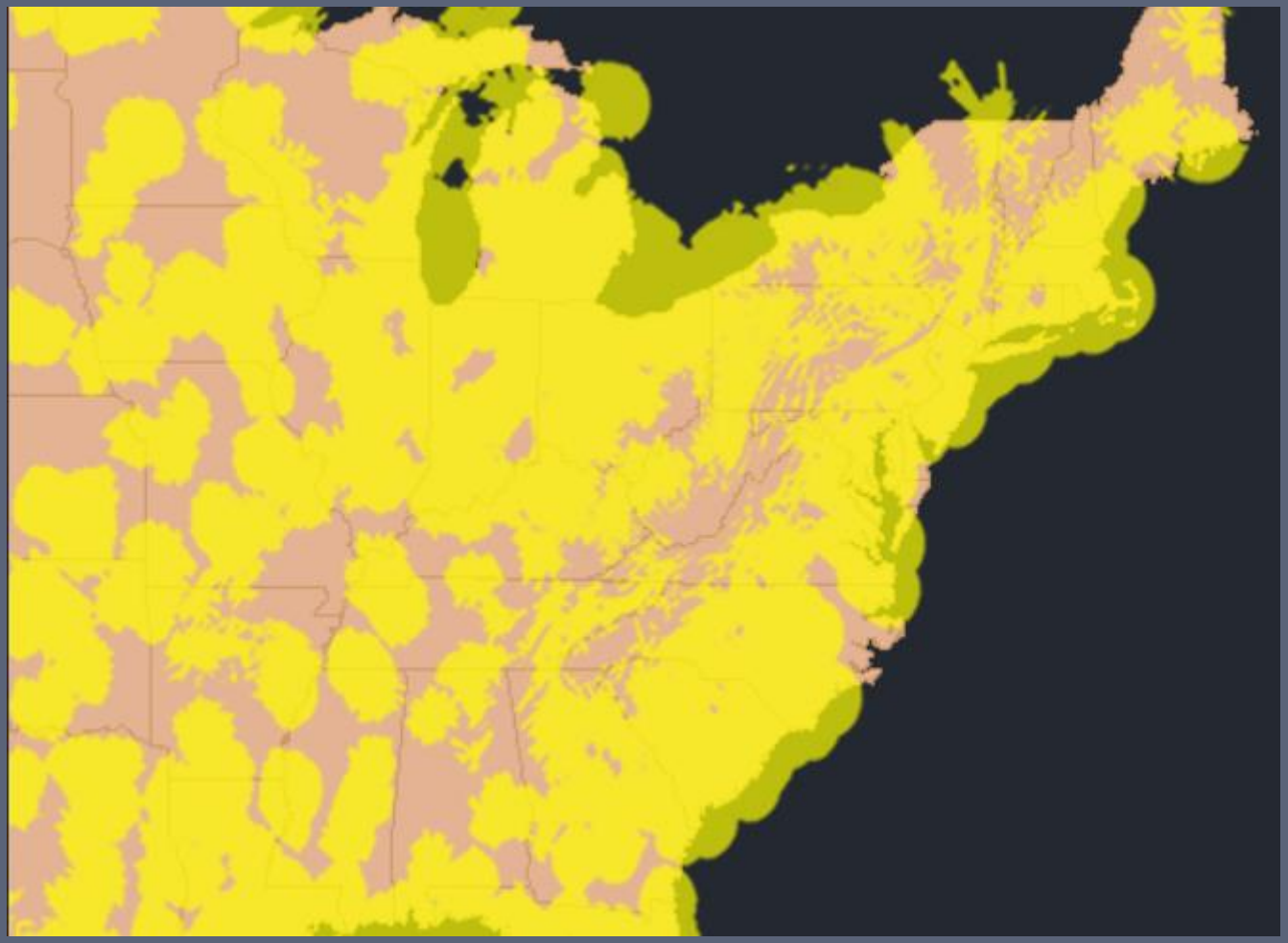


ADS-B Ground Stations

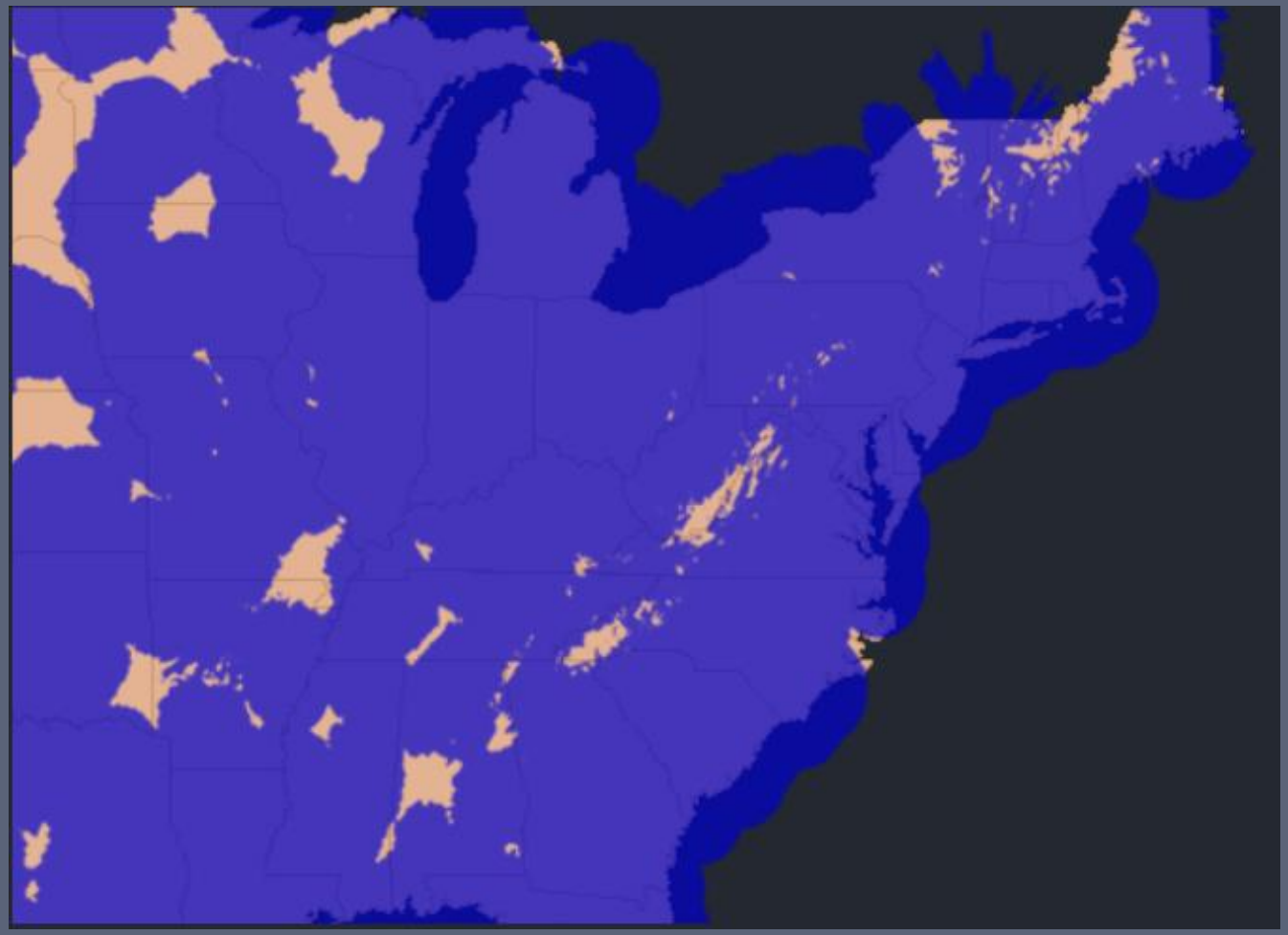


As of October 2015

ADS-B Northeast 500’ Coverage



ADS-B Northeast 1500’ Coverage



ADS-B Northeast 3000’ & 5000+’ Coverage

Spherics

Stormscope / StrikeFinder

Overview

- Detects electrical discharges from thunderstorms within 200 nm of the aircraft
- Antenna detects *intra-cloud, inter-cloud and cloud-to-ground* discharges from thunderstorms in all phases of development
- Works in the air or on the ground

- Advantages
  - *Can detect thunderstorms in all states of development*; weather radar will only detect storms when there is precipitation
  - *Not subject to attenuation* – can see "behind the storm"
- Disadvantages
  - *Calculating the distance is not an exact science:* is a strong signal from a weak flash nearby, or an intense flash far away?

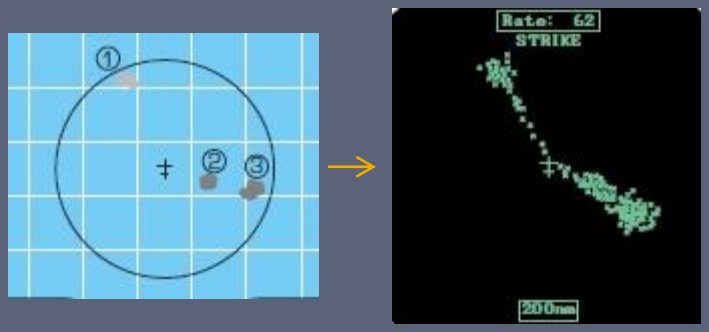
Relationship of Lighting and Turbulence

- Very strong updrafts and downdrafts are necessary to product lightning
  - *Lightning therefore correlates with turbulence*
- Rain doesn't always suggest lightning, and lightning can exist without rain
  - Therefore, *radar won't necessarily indicate where there is turbulence*
- The more frequent the lightning, the more severe the thunderstorm
  - Increasing frequency of lightning = growing thunderstorm
  - Decreasing frequency of lightning = dissipating thunderstorm

Display Modes

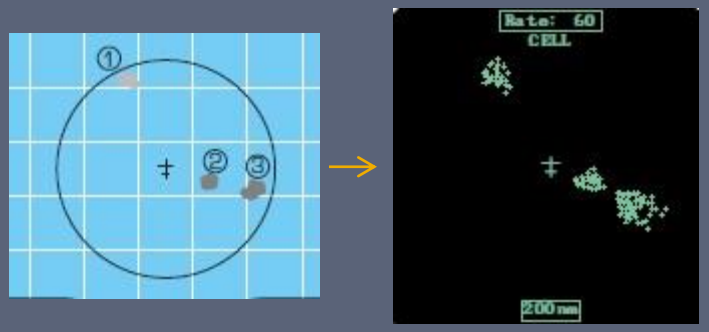
Strike Mode

- Displays individual strikes in their calculated location
- Strikes will often show up in a radial pattern from the aircraft



Cell Mode

- Algorithmic depiction of the location of individual cells
- Can be used to correlate the location of storm cells



Interpreting the Data

- Use "strike" mode when storms may be developing for more immediate detection of strikes
- Look for clusters of strikes to estimate the location of storm cells to avoid
  - Atmospheric instability associated with cumulus clouds, or developing or dissipating storms might cause randomly scattered discharge points
- Use "cell" mode when there are developing storms for better estimation of actual storm cell locations
- Monitor the strike data as you go, and look for *trends* in the location and frequency of the strike points
- Not all installations are coupled to the aircraft heading
  - Be sure to clear the screen when heading changes are made if this is the case

Final word on strike detection

- DO NOT USE FOR STORM PENETRATION PURPOSES!
  - Strike detection is best used for strategic *AVOIDANCE* of storms

- Unlike data link weather, stormscope data is real-time
  - Despite the impreciseness of the data, it is still useful for avoiding storms
    - Since there is a strong correlation between electrical discharges and convective wind shear, we can use the stormscope data to avoid turbulence associated with thunderstorms

Datalink Traffic

Benefits, Limitations, and Tips

Limitations and Benefits

Limitations

- Not all nearby traffic is shown
  - Radar-only aircraft without a transponder or that is outside of radar coverage are blind to the system
- Not all traffic is instantaneous
  - There is a delay in receiving some traffic (TIS-B and TIS-R)
- Not an active TCAS system
  - Relies on ATC ground radar and/or ADS-B Out participation

Benefits

- ADS-B (but not TIS-B) traffic is GPS-WAAS based, so position is highly accurate
- Works automatically and is continuously available
- *Enhances visual scanning for traffic*

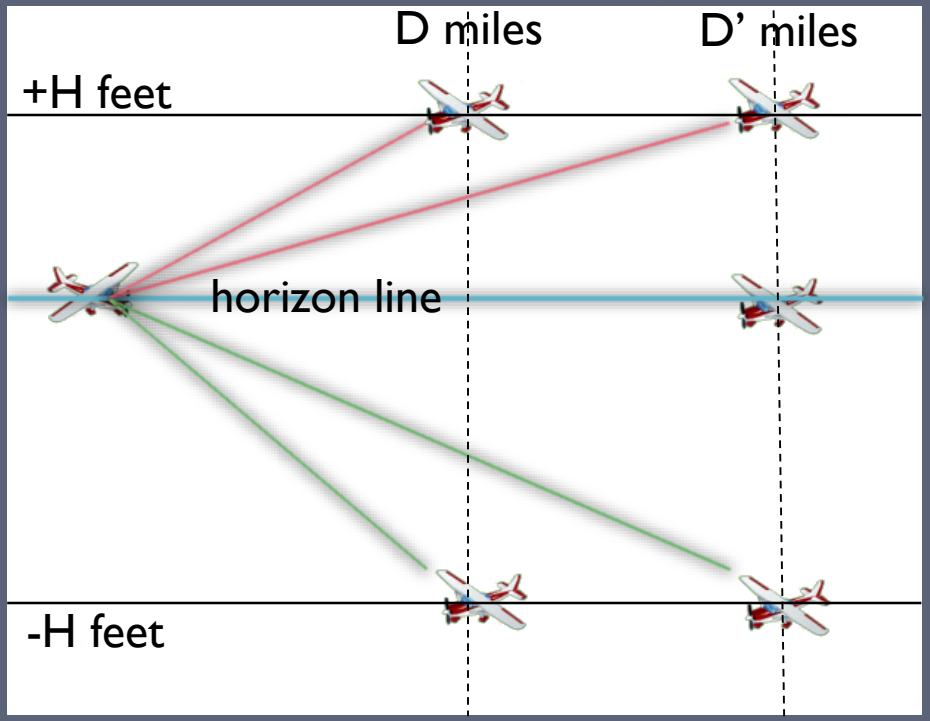
Tips

- Use the dedicated traffic page range rings to help determine distance to target
  - Also helps you see where the most important traffic is, free of any map distractions

- Use the map page with traffic to see what landmarks the traffic is near, to help localize your visual scanning area

Tips

- Traffic at your altitude will appear near the horizon
- Traffic above or below your altitude will appear above or below the horizon (respectively)
  - *Close-in traffic will appear farther* from the horizon line than traffic that is further away



Break Time!

Datalink Weather

Benefits, Limitations, and Tips

Limitations and Benefits

Limitations

- Data can be 20+ minutes old before being displayed
  - A lot can happen in 20 minutes, especially when there is convective weather
- Radar color scale is dependent on the service (ADS-B/XM WX/etc) and display device
  - Know what you have installed

Benefits

- Enhanced situational awareness
  - See where the weather is
- No need to go off frequency to get the weather
- View weather far ahead of your route to *make strategic decisions early*

SiriusXM WX vs FIS-B weather

SiriusXM WX

- Satellite-based transmission means data is available from virtually anywhere, *including on the ground*
- High-resolution data available nationwide
- Comprehensive weather data
- Subscription-based

FIS-B

- Ground-based transmission means data isn't always available
- US-only
- Low-to-medium resolution data, depending on scale (national or regional)
- Limited weather data
- Free

Weather Radar Basics

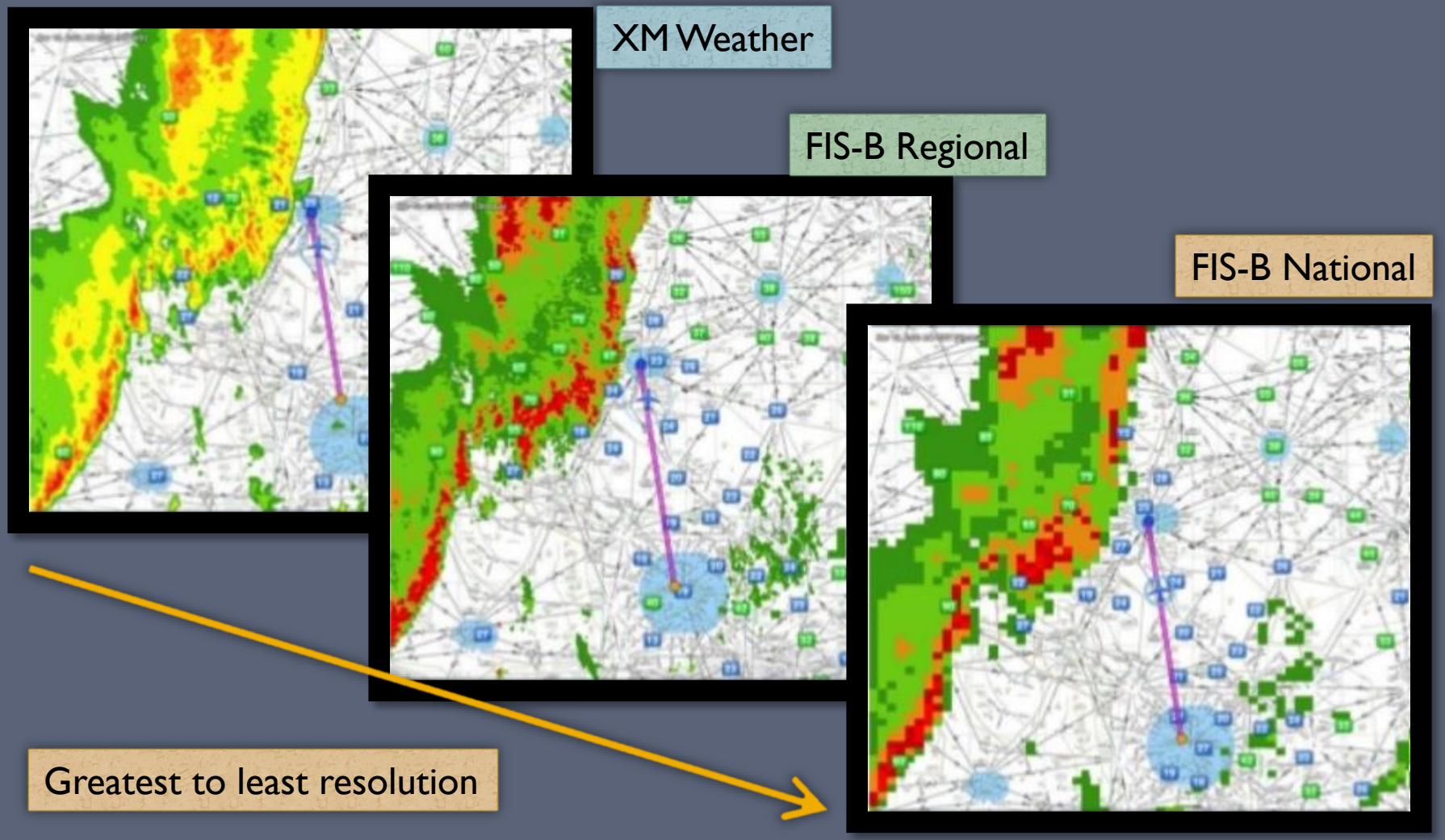
- Modern Doppler radar is based on reflectivity (Z): the amount of transmitted power that is return to the radar receiver
- Reflectivity is measured in dBZ (decibels of Z), which is a logarithmic scale
  - 60 dBZ is not 2x 30 dBZ, but more like 80x!

dBZ	Rainrate (in/hr)
65	16+
60	8.00
55	4.00
52	2.50
47	1.25
41	0.50
36	0.25
30	0.10
20	Trace

Composite vs Base Reflectivity

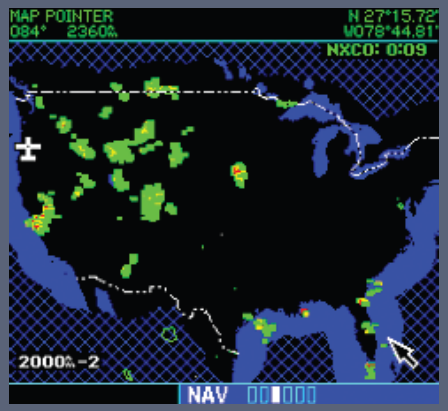
- Weather is 3-dimensional, but radar can only scan in 2-dimensional slices. Two methods are commonly used to display the 3-dimensional image
  - Base reflectivity: Only a single slice is shown of the lowest radar elevation tilt
  - Composite reflectivity: The strongest return from *multiple* elevations is shown in a composite image

SiriusXM WX vs FIS-B radar



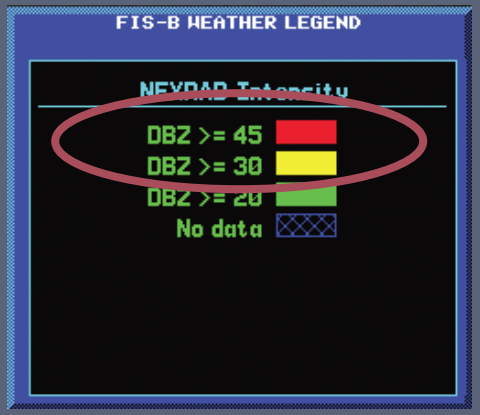
FIS-B Radar Types

- CONUS NEXRAD
  - 7.5NM x 5NM resolution
  - Composite radar imagery across all 48 Continental US states
- Regional NEXRAD
  - 1.5NM x 1NM resolution
  - Composite radar imagery of the local area (250nm from current aircraft location)



Tips

- Treat areas of reflectivity of 40dbZ or greater as convective areas, and avoid by *at least* 20nm
- Avoid areas of steep precipitation gradients, as they are more likely to have dangerous turbulence



Shallow Gradient

Steep Gradient

Tips

- Data-link radar is useful for *strategic, long-range/early avoidance* of weather
  - Due to the delay in generating the radar images, ***DO NOT*** use for close-in tactical weather penetration!
  - Only on-board radar and strikefinder (spherics) are real-time
- Use multiple weather presentations to develop the big picture
  - Radar + METARs + stormscope, for example
- Never fly in weather with data-link weather that you wouldn't fly in without it!
  - Data-link weather only helps you develop a course of action to avoid the weather

Real-World Examples

VFR & IFR Summer and Winter Scenarios

VFR Summer

- KDXR – KWST – KBID
- Ceilings: 5,000-7,000 BKN
- Visibility: 7 HZ
- Temp/Dewpoint: 80F/60F
- Wind from the SW
- Forecast calls for passing showers and thundershowers, but otherwise expected to remain VFR

Enroute Situation

1. Wind is from the SW, so we deviate south of the cell
2. We confirm that the cell is moving away from us (visually and data-link)
3. We turn back on course, maintaining a safe distance from the cell

Key Take-Aways

- *We could easily have made this flight without data-link weather, since we would have had to stay out of the clouds anyway*
- Data-link weather allowed us to determine that the cell was likely convective, so we gave it a wider berth than the VFR minimums require
  - *We stayed farther from the cell than we might have if we didn't have data-link weather*
- Data-link weather also gave us more information sooner than we would have had without it, so we were able to make an earlier decision to avoid the storm cell

VFR Winter

- KDXR – KAQW
  - Weekend skiing trip at Mt. Greylock with the family
- Ceilings: Unlimited
- Visibility: >20SM
- Temp/Dewpoint: 30F/9F
- Forecast calls for clear skies and windy conditions

VFR Winter

- While still 47NM out, we pick up the latest METAR for KAQW
  - Crosswind of 13 Kts, gusts of 18 Kts (exceeding crosswind component)
  - We decide to divert now

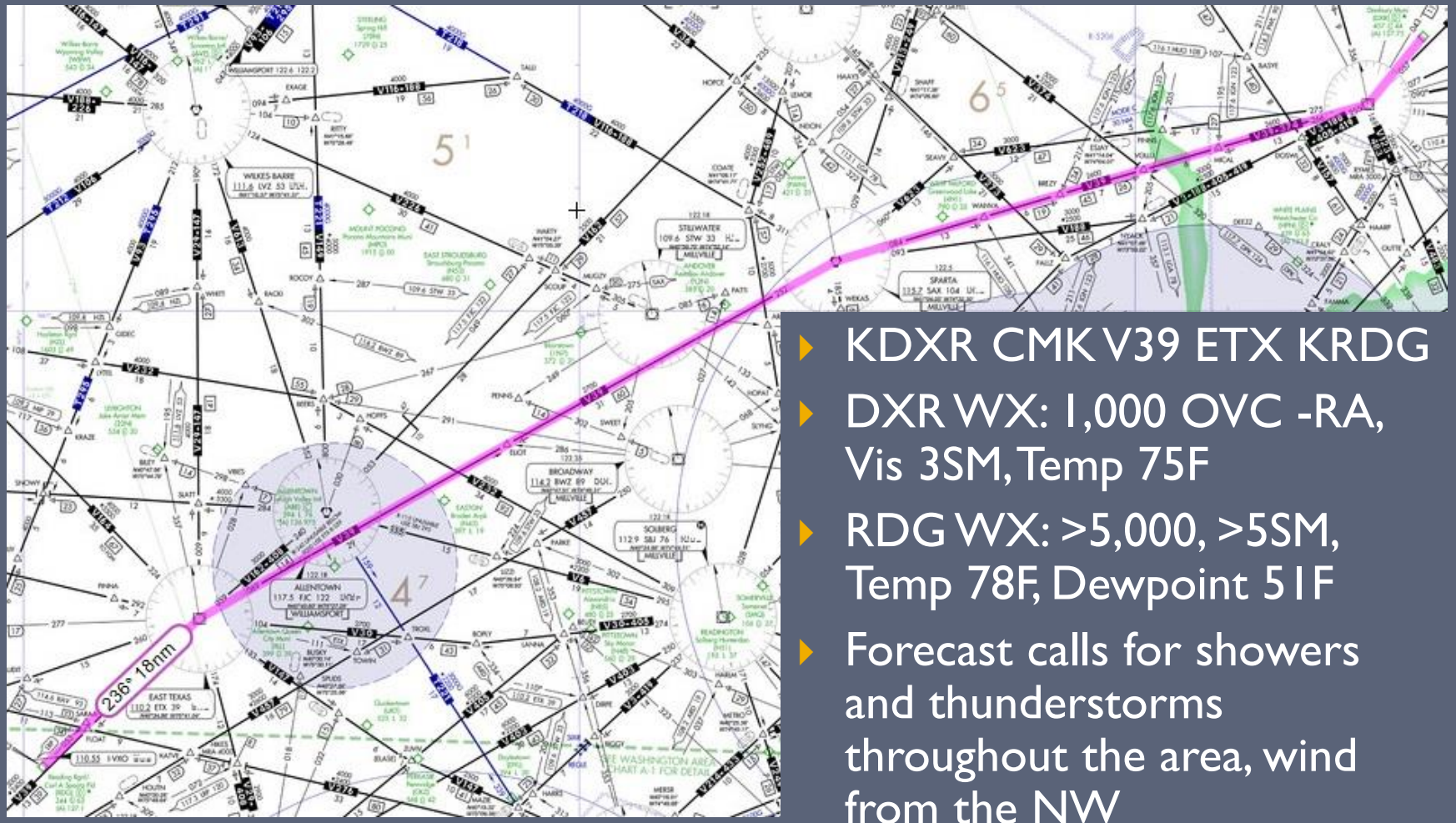
VFR Winter

- Pittsfield's wind and runway alignment is more favorable, and still within driving range of our original destination
  - Crosswind component of 6 Kts, gusting 9 Kts

Key Take-Aways

- *We could easily have made this flight without data-link weather*
- Data-link weather allowed us to check the destination weather while still outside of the ASOS reception range. Thus, we were able to make the decision to divert earlier than if we didn't have data-link weather.
- Just because we have data-link weather, doesn't mean we'll be able to complete the flight as planned. We may still need to develop alternate plans in-flight.
  - The advantage data-link weather provides us is being able to physically see the big picture and consider our options

IFR Summer



- KDXR CMK V39 ETX KRDG
- DXR WX: 1,000 OVC -RA, Vis 3SM, Temp 75F
- RDG WX: >5,000, >5SM, Temp 78F, Dewpoint 51F
- Forecast calls for showers and thunderstorms throughout the area, wind from the NW

IFR Summer

- Departing DXR, we see a storm cell ahead of us along the route
  - Don't be tempted to pass through the apparent gap!
- From the Stormscope page*, we can see that the storm cell has lightning and thus turbulence we want to avoid

* Or displaying lightning data if available

IFR Summer

- We divert around the cell and get a new IFR routing

- The Stormscope again confirms that the storm cells are convective with turbulence to be avoided

IFR Summer

- Notice how the gap in the previous storm cell has closed up?
- We also have a new storm cell to deal with on our new route

- We make an additional diversion around the new cell, and notice that it too is growing in intensity
- We're a little close, so we will want to widen out our diversion

IFR Summer

- Notice that the Stormscope is showing electrical activity in an area only showing as yellow on the radar
  - This is a good example of how the NEXRAD radar feed is not real-time and doesn't show the whole picture

IFR Summer

- Now we see another cell that will be passing over the field when we expect to be in inbound from the FAF

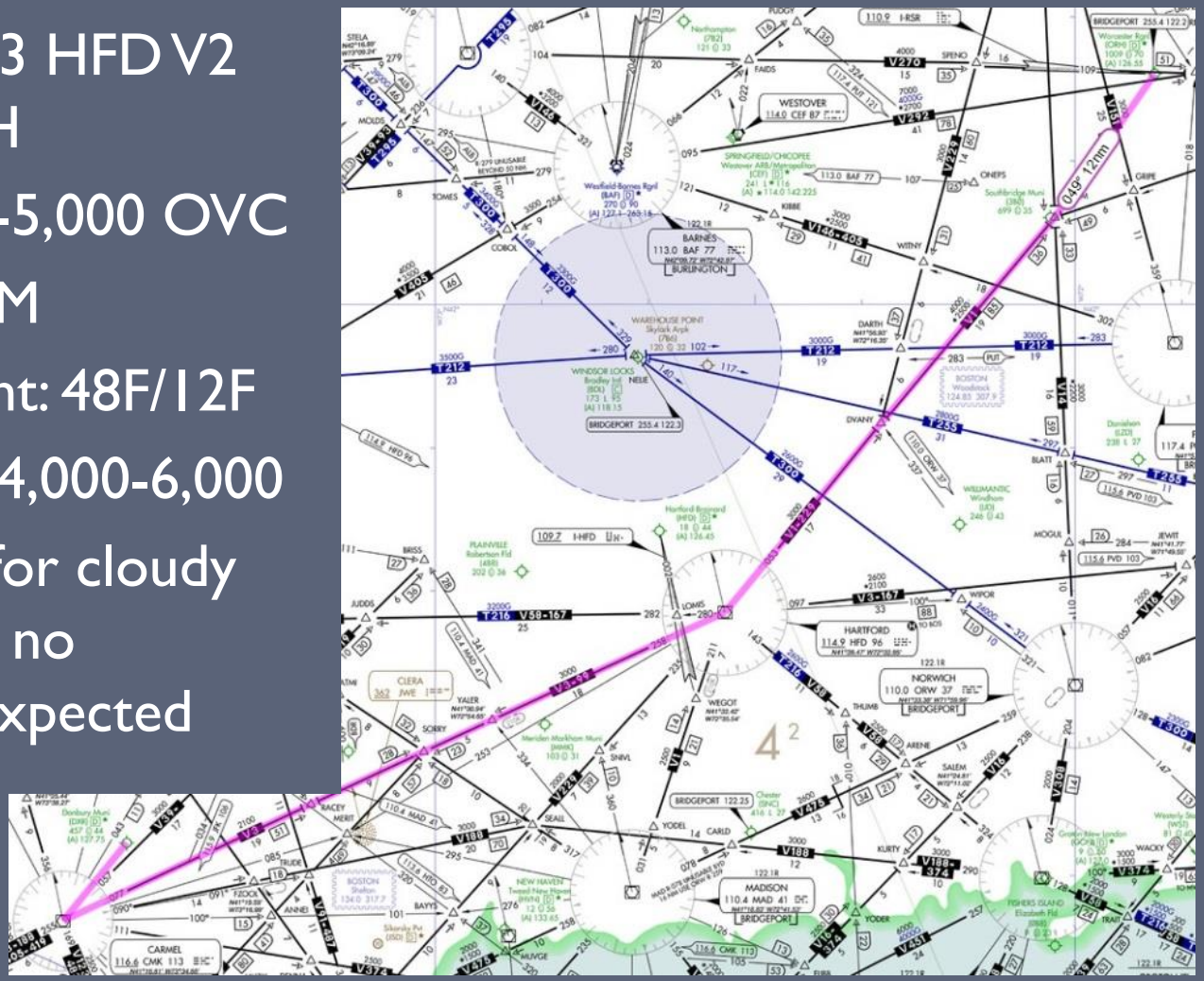
- We request a hold at ETX while we wait for the storm to pass
  - "N8107B, hold northwest of the ETX VOR on the 354 radial"

Key Take-Aways

- This flight would have been challenging without data-link weather, *but still would have been doable*.
  - It may have required diverting to wait out the storms, *but there's no guarantee you won't need to do that anyway*. It just happens that this particular scenario worked out.
- *However, we must still maintain at least 20NM from the edges of convective activity.* ***Data-link weather does not change this!***
- In this scenario, we saw how what looked like a gap quickly became a major storm cell. Don't be suckered into flying through a gap, even if ATC suggests it!
  - Data-link weather doesn't relieve you of your PIC authority

IFR Winter

- KDXR CMK V3 HFD V2 GRAYM KORH
- Ceilings: 3,000-5,000 OVC
- Visibility: >10SM
- Temp/Dewpoint: 48F/12F
- Freezing level: 4,000-6,000
- Forecast calls for cloudy conditions but no precipitation expected



IFR Winter

- Departing DXR, we see we'll be passing near a cell
  - Our en-route cruising altitude is 7,000, and we're expecting to pass through the 3,000-5,000 overcast well before the cell

- We're now at our cruising altitude and in the clear. No icing was picked up during the climb, so we continue on, but ready to divert at any moment

IFR Winter

- We see another cell ahead of us. We will need to descend soon, but we request from ATC a "pilot's discretion" descent.
- Further checking the METARs, we see most areas are VFR or MVFR, so our landing options are still open if necessary.

Key Take-Aways

- This flight was likely beyond some of your personal minimums from a risk-analysis point of view, especially with a non-FIKI aircraft. *Data-link weather in this case only ensured we would remain within our own risk tolerance level.*
  - **Data-link weather should *not* be used to raise your risk tolerance or accept worse conditions than you would otherwise fly in!**
- The initial go/no-go decision must still be made on the ground. Only a proper preflight briefing can provide us with the full picture.
  - However, as always, we must continually be making a continue/divert decision en-route and not be afraid to divert if necessary.
  - This scenario assumed a "continue" decision, but only for illustrative purposes. A "divert" (or "no-go") decision certainly would have also been a valid decision.

Final Take-Aways

Final Take-Aways

- Proper preflight briefings are still necessary even with data-link weather
- Use data-link weather to make earlier decisions to divert or deviate, but *never use it to push your risk tolerance!*
- Data-link weather doesn't change your personal proficiency or aircraft performance; you may still have to cancel the flight or change your plans en-route

Final Take-Aways

- Don't focus so much on the weather that you forget the basics: aviate (including proper checklist usage), navigate, communicate

- **Data-link traffic doesn't relieve you of your responsibility to "see-and-avoid"**
  - "Got it on the fish-finder" and other similar phrases are useless!
  - Either you have *visually* identified the traffic, or you haven't!

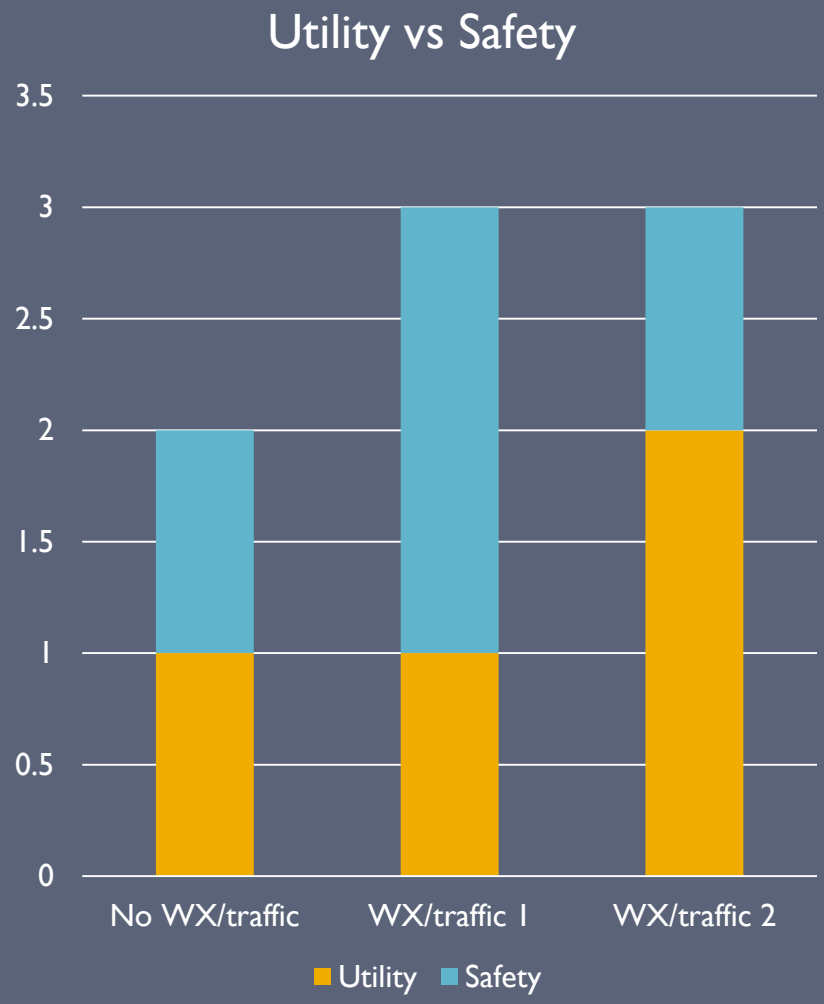
Final Take-Aways

- Don't forget to still look out the window for traffic and weather avoidance

- As with any tool (GPS, autopilot, etc), data-link weather and traffic can be abused to the point of making a flight *more* risky if not used responsibly!
  - It's up to you as PIC to use it responsibly
  - If you don't accept the limitations of the tool, it's better to not use it at all
    - But don't let this fact keep you from learning how to use it!

Final Take-Aways

- Advanced technology can be used to maintain:
  a) the same utility of the aircraft with an increased level of safety
  b) the same level of safety with increased utility
  - It's up to you as PIC to determine which viewpoint to take



More Information

- Flying 20 Club "Library"
  - GDL 84/88 Pilot's Guide
  - GTX 330ES Manual
  - WX-500 Stormscope Manual
  - GNS 400W Optional Display Pilot's Guide
- AOPA
  - IFR Insights: Cockpit Weather
- National Weather Service
  - JetStream Online School for Weather
  - theweatherprediction.com
- Pilot Workshops / Rod Machado
  - Radar Imagery Explained
- FAA.gov
  - AC 00-6A
  - AC 00-24C
  - AC 00-63A
  - AIM

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