



**Federal Aviation
Administration**

Turbulence Nowcast Focus Group Assessment Results and Recommendations Briefing

Presented to: ANG-C61, Turbulence Lead

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Overview

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Introduction



Introduction

- The Aviation Weather Research Program (AWRP) funds the National Center for Atmospheric Research (NCAR) Research Applications Laboratory (RAL) to develop a turbulence nowcast product.
- The Aviation Weather Demonstration and Evaluation (AWDE) Services of the Weather Engineering & Evaluation Branch (ANG-C63) was tasked to solicit user input regarding the suitability and usability of the turbulence nowcast product for decision making within the users' operational environments.
- The Aviation Weather Center (AWC) was tasked to solicit user input regarding the usability of the turbulence nowcast product and to identify if and how the product would be used in an operational environment.



Background



Background

- Turbulence contributes significantly to safety, efficiency, and Air Traffic Controller (ATC) workload.
 - Turbulence results in 65,000 incidents per year¹.
 - Turbulence accounts for 75% of all weather-related accidents and incidents¹.
- Research and development has focused on developing a turbulence nowcast product to provide short-term forecasts with updates every 15 minutes.
- The goal is to improve turbulence forecasting capabilities throughout the National Airspace System (NAS).

¹National Center for Atmospheric Research & University Corporation for Atmospheric Research – Research Applications Laboratory. Turbulence: Predicting Turbulence Using Operational Numerical Prediction Models. <https://ral.ucar.edu/aap/turbulence>



Assessment Objectives

- Determine when users will use a turbulence nowcast product in operational environments.
- Determine how users will use a turbulence nowcast product to aid in decision making strategies.
- Determine if the turbulence nowcast product has the information needed for decision making.
- Gather user feedback to determine product improvements as related to users' operational environments.



Approach



Participants

- AWDE conducted 4 focus groups at the following locations:
 - AWDE Concept and Product Assessment Capability Laboratory (CPAC), FAA William J. Hughes Technical Center in Atlantic City, NJ
 - August 9 and 16, 2017
 - 2 Part 121 Pilots
 - 1 Airline Operations Center (AOC) Dispatcher
 - 1 AOC Meteorologist
 - 1 Traffic Manager
 - 1 United States Coast Guard (USCG) Helicopter Pilot
 - November 1 – 3, 2017
 - 5 General Aviation (GA) Pilots
 - November 29, 2017
 - 4 Center Weather Service Unit (CWSU) Meteorologists-in-Charge (MICs)
 - Southwest Airlines Operations Center (AOC) in Dallas, TX
 - November 7 – 8, 2017
 - 5 Part 121 Pilots
 - 4 AOC Dispatchers
 - 3 AOC Meteorologists



Participants

- AWC sent out a questionnaire via e-mail on May 16, 2017.
 - Responses to the questionnaire were from:
 - 1 GA Pilot
 - 1 Meteorologist
 - 1 CWSU MIC



Approach

- Focus groups were conducted with multiple users in attendance.
- Participants were asked to think of a typical real-life scenario to simulate the processes done for pre-flight and in-flight.
- Participants were told the turbulence nowcast product was the first tool to use for turbulence information.
- Storyboards of the turbulence nowcast product were used to present and detail the product's capabilities while walking through the real-life scenario.
- The Storyboards contained structured questions focusing on:
 - How and when participants use turbulence information for pre-flight and in-flight
 - Usability of the product's controls and drop-down menus
 - Display and presentation of the turbulence forecast
 - Zoom capability



Approach (cont'd)

- Upon completion of the storyboard presentation, participants completed a 5-point Likert scale questionnaire.
- Questions were designed to capture ratings about the product's usability and suitability for decision making.
- Each question included space for additional comments.
- Questionnaires included open-ended questions about users' needs for additional information or capabilities in the product.



Approach (cont'd)

- AWC used a 5-point Likert scale questionnaire to gather participants' feedback on the usability of the turbulence nowcast product and to identify if and how the product would be used in an operational environment.
- AWC distributed the questionnaire via e-mail to possible users of the turbulence nowcast product.
- Participants were asked to interact with the turbulence nowcast product then complete the questionnaire.



Results:

How Turbulence Is Used During Pre-Flight and In-Flight



Questions and Results

Question		GA Pilots	Part 121 Pilots	USCG Helicopter Pilot
At what point do you look at turbulence when pre-flight planning?	Pre-Flight	Once or twice before EDT	Once before EDT	Only reviews for cross-country flights
	In-Flight	When encountering turbulence or approaching clouds, will check turbulence to avoid	Listen continuously to ATC frequency for turbulence reports	Does not use
What lead times do you typically need in relation to turbulence?	Pre-Flight	24 hours	10-60 minute	Does not use
	In-Flight	10-15 minutes to change altitude or direction	10-30 minutes to give flight attendants time to clear cabin	Does not use
How often do you look at turbulence?	Pre-Flight	Once or twice before EDT	Once before EDT	Does not use
	In-Flight	Rarely	Listen continuously to ATC frequency for turbulence reports	Does not use
What impact does turbulence have on your flight planning?	Pre-Flight	Influence go-no-go decisions, routes, altitudes	Safety issues with crew and passengers – affects route, altitude, and fuel	Does not use
	In-Flight	Reroute and altitudes	Safety issues with crew and passengers – affects route, altitude, and fuel	Does not use
Is an update rate of 15 minutes adequate for flight planning?	Pre-Flight	YES	YES	Does not use
	In-Flight	YES	YES	Does not use



Questions and Results

Question		AOC Dispatchers	AOC Meteorologists	CWSU MICs	Traffic Manager
At what point do you look at turbulence when pre-flight planning?	Pre-Flight	2 hours before ETD	Only if SIGMET issued	Check for convective weather first, then for turbulence	Periodically
	In-Flight	Continuously	Only if SIGMET issued	Check for convective weather first, then for turbulence	Periodically
What lead times do you typically need in relation to turbulence?	Pre-Flight	2-3 hours	Does not use	8-12 hours to plan for work shift	2 hours
	In-Flight	30 minutes or more for alerts	Does not use	8-12 hours to plan for work shift	2 hours
How often do you look at turbulence?	Pre-Flight	Once before ETD	Check if SIGMET issued	If convective weather, often. If weather is clear, once	Continuously
	In-Flight	Continuously	Check if SIGMET issued	If convective weather, often. If weather is clear, once	Continuously
What impact does turbulence have on your flight planning?	Pre-Flight	Safety issues with crew and passengers – affects route, altitude, and fuel	Does not use	Issuing Center Weather Advisory (CWA)	Affects safety, speed, routes, and fuel
	In-Flight	Affects safety, route, altitude, and fuel	Does not use	Issuing CWA	Affects safety, speed, routes, and fuel
Is an update rate of 15 minutes adequate for flight planning?	Pre-Flight	YES	Does not use	YES	YES
	In-Flight	YES	Does not use	YES	YES

Questions and Results

- GA and Part 121 Pilots, AOC Dispatchers, CWSU MICs, and Traffic Managers all use turbulence forecast for both pre-flight and in-flight.
 - All users noted the need to check turbulence if convective weather is occurring for both pre-flight and in-flight.
 - Turbulence has a direct impact on many decisions:
 - GA Pilots: Go-no-go, routes, altitudes
 - Part 121 Pilots, AOC Dispatchers, Traffic Managers: Safety, routes, altitudes, fuel
 - CWSU MICs: Issue Center Weather Advisory (CWA)
- AOC Meteorologists and USGC Helicopter Pilot stated turbulence does not directly affect flight planning.
 - AOC Meteorologists: Only check turbulence if a SIGMET is issued.
 - USCG Helicopter Pilot: Will only check turbulence for cross country flights, however, in spite of forecast missions still need to be complete. The only impact would be to change route.



Results: Usability



Nowcast Controls

Experimental GTGN

INFO
GTG Forecast
Aircraft: Region:
Vertical level: Analysis time:
Please select aircraft

- *For pre-flight/in-flight planning, does the Nowcast provide enough options to view turbulence information for decision making?
 - All user groups stated the Aircraft, Vertical Level, and Analysis Time provided adequate options for decision making and were easy to use.
 - GA Pilots and Traffic Managers stated the zoom capability was not adequate to support decision making.
 - A better zoom capability is needed to distinguish between the different severity colors along a route.
 - The zoom option should be available on a route, not a region.

**Results include AWC questionnaire responses.*

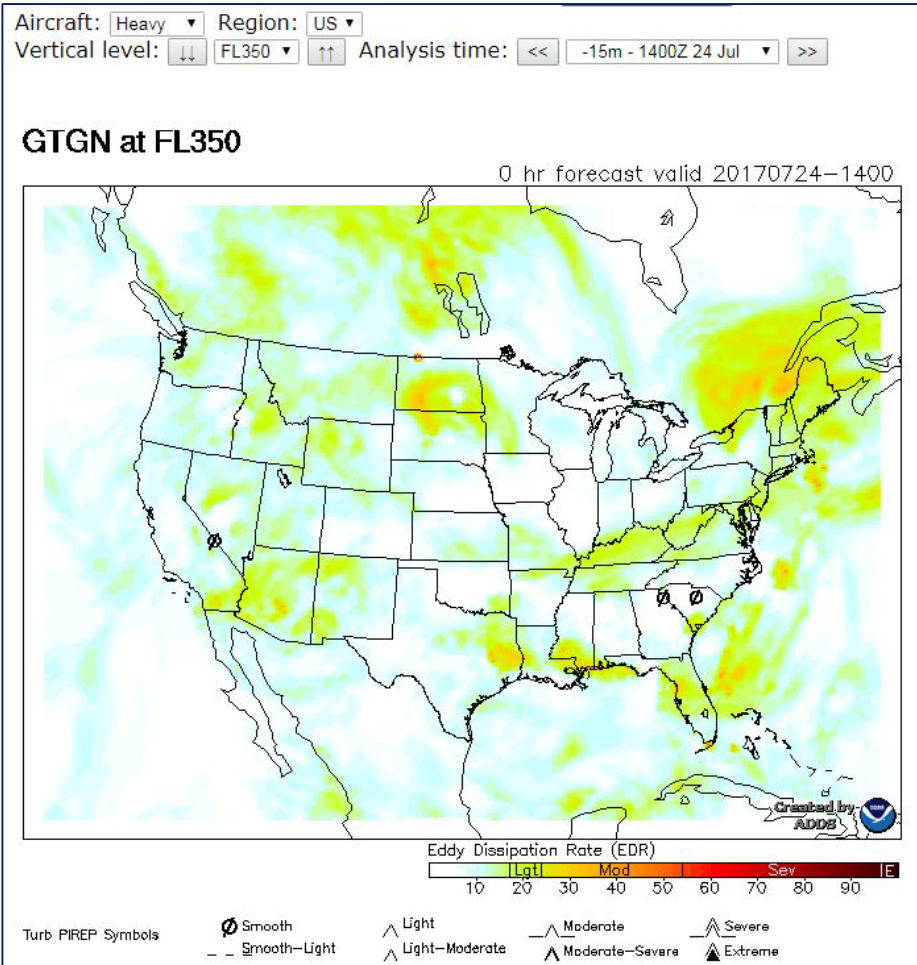


Results:

Display and Presentation



Display and Presentation



Questions and Results

Question		GA Pilots	Part 121 Pilots	USCG Helicopter Pilot
When would you use this nowcast turbulence information?	Pre-Flight	X	X	X
	In-Flight			
*When is it most useful? Is it useful?		Prior to departure	Prior to departure	Prior to cross-country flight
*Is the update rate of 15 minutes adequate for decision making?	Pre-Flight	YES	YES	YES
	In-Flight	YES	YES	YES
Does the display provide enough information for decision making? If not, what additional information is needed?		YES	YES	N/A
How often would you reference the nowcast?	Pre-Flight	Once	Once	Only for cross-country
	In-Flight	Would not use	Would not use	Would not use
Are there additional capabilities needed to make this display more useful?		Better zoom	10 minute update rate	None
*Is there additional information needed to aid in decision making?		Access to PIREPs for weather details	Access to PIREPs for weather details	Access PIREPS for aircraft type

**Results include AWC questionnaire responses.*



Questions and Results

Questions		AOC Dispatchers	AOC Meteorologists	CWSU MICs	Traffic Manager
When would you use this nowcast turbulence information?	Pre-Flight	X		X	X
	In-Flight	X		X	X
*When is it most useful? Is it useful?		Monitoring in-flight traffic	Not useful	Monitoring in-flight traffic	Monitoring in-flight traffic
*Is the update rate of 15 minutes adequate for decision making?	Pre-Flight	YES	YES	YES	YES
	In-Flight	YES	YES	YES	YES
Does the display provide enough information for decision making? If not, what additional information is needed?		YES	YES	ARTCC boundaries	Routes
How often would you reference the nowcast?	Pre-Flight	Once	Would not use	Often	Periodically
	In-Flight	Continuously	Would not use	Often	Periodically
Are there additional capabilities needed to make this display more useful?		Select a range of altitudes to display	None	Display sectors, and select a range of altitudes to display	Better zoom
*Is there additional information needed to aid in decision making?		Access to PIREPs for weather details	Access to PIREPs for weather details	Access to PIREPs for weather details	Routes

**Results include AWC questionnaire responses.*



Display and Presentation Results

- All pilots, AOC Dispatchers, CWSU MICs, and Traffic Managers stated the need for turbulence nowcast information for pre-flight.
- AOC Dispatchers, CWSU MICs, and Traffic Managers noted turbulence nowcast information was needed for in-flight as well.
- GA Pilots, CWSU MICs and Traffic Managers need ARTCC boundaries and routes displayed.
- GA and Part 121 Pilots, and Traffic Managers require a better zoom capability.
- AOC Dispatchers need the ability to select a range of altitudes for display on the map.
- All participants, except Traffic Managers, need to have access to PIREPs on the product.



Web Usability (AWC)

- The presence of PIREPs was helpful:
 - The GA Pilot found PIREPs helpful but noted:
 - PIREPs icons are too large.
 - PIREPs icons blended into state borders.
 - The Meteorologist found PIREPs helpful but noted:
 - PIREPs need to vary with zoom level.
 - PIREPs need an on/off toggle.
 - CWSU MIC: To be useful, the product needs to provide the capability to read the PIREPs.
- The Forecast Time increment provided enough historical information for decision making. If not, why?
 - GA Pilot, Meteorologist, and CWSU MIC: The users found the historical information useful for decision making.

AWC questionnaire responses that could not be combined with AWDE questions.



Web Usability (AWC)

- It was easy to see areas of turbulence I was interested in:
 - The Meteorologist could not directly view areas of interest because the zoom capability was inadequate.
 - CWSU MIC easily saw areas of interest.
- It was easy to determine the severity of turbulence in areas I was interested in:
 - The GA Pilot stated turbulence intensity was easy to determine.
 - Meteorologist and CWSU MIC: The users stated turbulence intensity was very difficult to determine due to zoom capability not being adequate.

AWC questionnaire responses that could not be combined with AWDE questions.

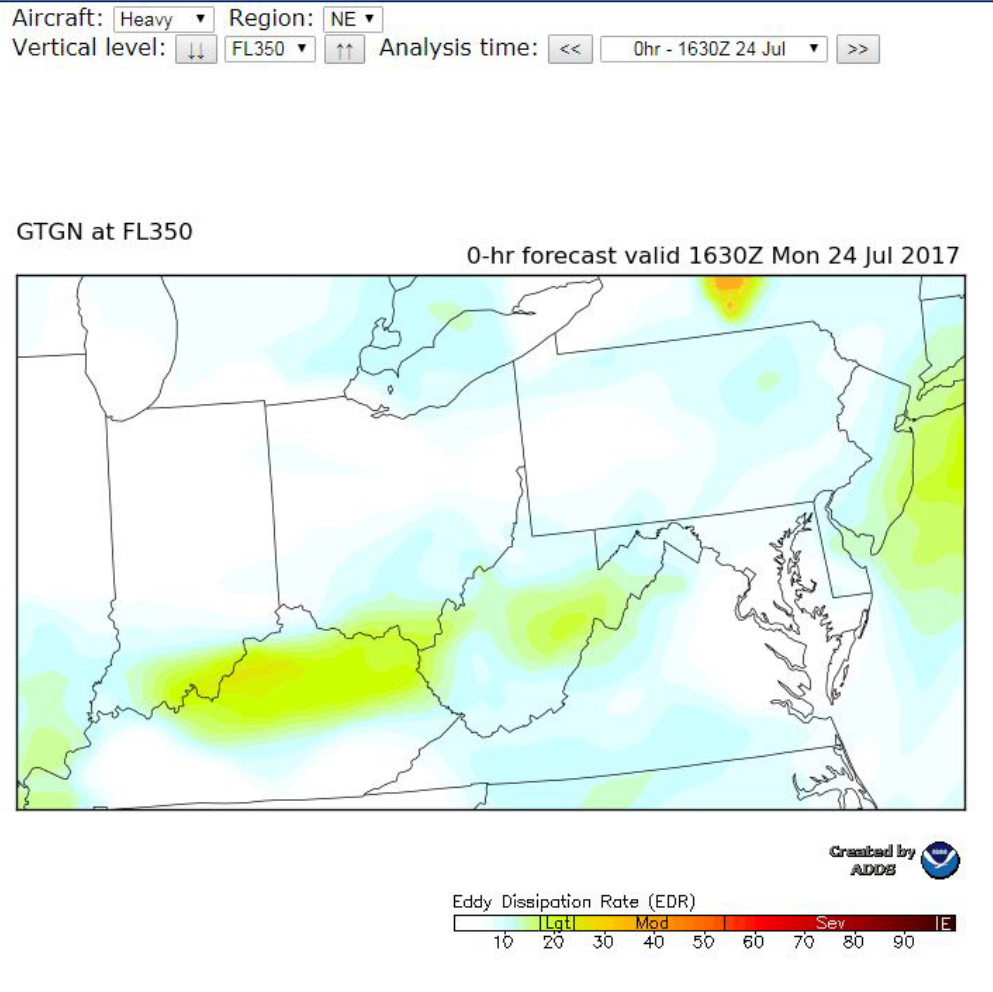


Results:

Zoom Capability



Nowcast - Regional



Regional Zoom Results

- Most users found the regional zoom effective for locating regional areas of concern.
- All users required a better zoom capability to:
 - Easily distinguish between turbulence severity levels.
 - Easily find areas where turbulence is less severe.



Results: Questionnaire



Effectiveness Scores

Question	GA Pilots (n=5) Median (Mean)	Part 121 Pilots (n=7) Median (Mean)	AOC Dispatchers (n=5) Median (Mean)	AOC Meteorologists (n=4) Median (Mean)	CWSU MICs (n=4) Median (Mean)	Traffic Manager (n=1) Median (Mean)	USCG Helicopter Pilot (n=1) Median (Mean)
1. Having a turbulence tool for pre-flight planning is:	4 (3.4)	4 (4.3)	5 (5)	5 (4.8)	4.5 (4.5)	5 (5)	2 (2)
2. An update rate of 15 minutes for pre-flight planning is:	3 (3.4)	4 (4.1)	4.5 (4.5)	5 (4.8)	4.5 (4.5)	4 (4)	5 (5)
3. For pre-flight planning, using the nowcast turbulence product to check planned altitudes along the route is:	5 (3.8)	5 (4.6)	4 (3.4)	4.5 (4.5)	4 (4.3)	5 (5)	4 (4)
4. For pre-flight planning, the number of options to view turbulence are:	4.5 (4.5)	4 (4.3)	5 (4.6)	4 (4)	3 (3)	5 (5)	5 (5)
5. Having a turbulence tool for in-flight planning is:	3 (3.2)	5 (4.6)	5 (4.6)	5 (5)	5 (4.3)	5 (5)	2 (2)
6. An update rate of 15 minutes for in-flight planning is:	3 (3.6)	4 (3.7)	4 (4.4)	5 (5)	4 (3.3)	4 (4)	N/A



Effectiveness Scores (cont'd)

Question	GA Pilots (n=5) Median (Mean)	Part 121 Pilots (n=7) Median (Mean)	AOC Dispatchers (n=5) Median (Mean)	AOC Meteorologists (n=4) Median (Mean)	CWSU MICs (n=4) Median (Mean)	Traffic Manager (n=1) Median (Mean)	USCG Helicopter Pilot (n=1) Median (Mean)
7. For in-flight planning, using the nowcast turbulence product to check planned altitudes along the remainder of the route is:	4 (3.6)	5 (4.6)	5 (4.4)	5 (4.8)	4 (3.7)	5 (5)	N/A
8. For in-flight planning, the number of options to view turbulence are:	3.5 (3.5)	5 (4.4)	5 (4.8)	4.5 (4.5)	2 (2.7)	5 (5)	4 (4)
9. Using the nowcast turbulence product on a desktop computer would be:	4 (3.8)	5 (4.4)	5 (5)	4.5 (4.5)	4.5 (4.5)	4 (4)	5 (5)
10. Using the nowcast turbulence product on a laptop computer would be:	4 (3.8)	5 (4.4)	5 (4.5)	4.5 (4.5)	4.5 (4.5)	4 (4)	5 (5)
11. Using the nowcast turbulence product on a tablet computer would be:	5 (4)	5 (4.7)	5 (5)	5 (4.8)	4.5 (4.5)	4 (4)	5 (5)
12. Regional zoom is:	5 (4.2)	5 (4.9)	5 (5)	5 (4.8)	4 (4.3)	5 (5)	5 (5)



Questionnaire Comments

- (GA Pilots) The product needs a better zoom capability.
 - The zoom should enable users to zoom into specific areas of interest and clearly see the distinction of turbulence severity levels.
 - The zoom capability should make it easier to see the difference in turbulence severity over small areas.
- (Part 121 Pilots) During in-flight, PIREPs or turbulence reports on the ATC frequency are more likely to be used than a map display.
- (AOC Dispatchers) Although a 15-minute update rate is an improvement, dispatchers would prefer instantaneous updates.
- CWSU MICs
 - A better zoom capability is needed to view specific routes.
 - The nowcast would be more effective if a range of altitudes could be selected then displayed on the map.
- (USCG Helicopter Pilot) Missions would not change due to turbulence.



Conclusions



Conclusions

1. Objective: Determine when users will use a turbulence nowcast product in operational environments.

- GA and Part 121 Pilots, AOC Dispatchers, CWSU MICs, USCG Helicopter Pilots and Traffic Managers would use the product during pre-flight planning. Helicopter Pilots would only use the product for pre-flight planning on cross-country missions.
- AOC Dispatchers, CWSU MICs, and Traffic Managers would use the product during in-flight.
- AOC Meteorologists would not use the product. Users do not have a need to view or reference turbulence information for decision making.



Conclusions

2. Objective: Determine how users will use a turbulence nowcast product to aid in decision making strategies.

- GA Pilots would use the product pre-flight, however, it would not be their first source of turbulence information. Flight Service Station (FSS) would remain as the source of turbulence information.
- Part 121 Pilots would use the product pre-flight to check if turbulence conditions have changed since receiving the dispatch flight packet. If Moderate and/or Severe turbulence is predicted along the route, pilots would plan an altitude change or reroute to minimize risk of injury to crew and passengers.



Conclusions

2. Objective: Determine how users will use a turbulence nowcast product to aid in decision making strategies.

- AOC Dispatchers would use the product to monitor turbulence conditions along a flight's route:
 - To increase safety and reduce fuel consumption, if a Dispatcher notices an area of Moderate turbulence, an alert will be issued to the pilot, who can change altitude or route.
 - If the Moderate turbulence cannot be avoided, the pilot will have flight attendants secure the cabin to prevent injury.
 - If a Dispatcher notices an area of Severe turbulence, the area must be avoided entirely, and an altitude change or reroute must be planned around the turbulence.



Conclusions

2. Objective: Determine how users will use a turbulence nowcast product to aid decision making strategies.

- CWSU MICs would use the product often per shift if weather was predicted to be bad or after receiving reports of unexpected turbulence.
 - MICs would alert ATCs to areas which must be avoided due to turbulence, and the 15-minute update rate would help MICs alert ATCs when an area is free of turbulence, and traffic may resume.
 - The product would allow for forecasting turbulence severity and altitude.
- Traffic Managers would use the product periodically. If an area of Severe turbulence appeared, the Traffic Manager would issue a restriction and reroute traffic.
- USCG Helicopter Pilot would use only the product if the mission was to fly cross country. Based on the information different routes may be used.



Conclusions

2. Objective: Determine how users will use a turbulence nowcast product to aid decision making strategies.

- GA Pilots, AOC Meteorologists, and the USCG Helicopter Pilot would be unlikely to use the product.
 - GA Pilots prefer to call FSS for turbulence forecasts.
 - The USCG Helicopter Pilot would use the product during pre-flight planning for a cross-country flight. If an area of turbulence would significantly affect arrival time, a reroute may be planned.



Conclusions

3. Objective: Determine if the current turbulence nowcast product has the information needed for decision making.

- GA and Part 121 Pilots and Traffic Managers require a better zoom capability to distinguish severity levels and to view turbulence along routes to assess routes with less turbulence.
- All participants, except for Traffic Managers, require access to PIREPs via the tool.
- GA Pilots and Traffic Managers require routes displayed on the map.
- CWSU MICs require ARTCC boundaries on the map.



Conclusions

4. Objective: Gather user feedback to determine product improvements as related to the users' operational environments.

- Users stated the need for additional capabilities:
 - A better zoom capability.
 - Direct access to PIREPs via the product.
 - AOC Dispatchers, CWSU MICs, and the Traffic Manager stated the need to be able to select a range of altitudes and display that range of altitudes on the map.



Recommendations

- **Improve the zoom capability.**
- **Provide access to PIREPs.**
- **Add ARTCC boundaries.**
- **Add route overlays.**
- **Allow users to select a range for the altitude.**



Deliverables

Task	Date
Focus Group Assessment Plan and Data Collection Tools	August 4, 2017
Recruitment for participants	June 12-October 31, 2017
Conduct focus groups	August 9-November 29, 2017
Final Report/Briefing	December 29, 2017

