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Feasibility, Utility and Usability of Pilot Reports (PIREPs) Submission and Retrieval Using VHF Radio, Cloud Computing and Artificial Intelligence Technologies (A Proof-of-Concept Study)

Daniela Kratchounova, Ph.D.[1]
Hannah Baumgartner, Ph.D. [1]
Cory Smith[2]
Mark Underwood[2]
Larry Langebrake[3]
Tom George[4]
Adam White[5]

[1] Federal Aviation Administration
Civil Aerospace Medical Institute (CAMI)
6500 S. MacArthur Blvd.
Oklahoma City, OK 73125
[2] Resource Data Inc.
560 E 34th Ave 100
Anchorage, AK 99503
[3] Connectsix, LLC
4707 140th Avenue North #212
Clearwater, FL 33762
[4] Aircraft Owners and Pilots Association (AOPA)
421 Aviation Way
Frederick, MD 21701
[5] Alaska Airmen's Association
4200 Floatplane Dr.
Anchorage, AK 99502

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16. Abstract

Pilot reports (PIREPs) are reports describing in-flight weather conditions submitted by pilots that provide crucial weather information to other pilots for pre-flight and in-flight planning. The current PIREP system is antiquated, prone to error, and has been identified as a safety concern according to a 2017 National Transportation Safety Board Special Investigation Report. This paper describes the results from a proof-of-concept (POC) study investigating the feasibility, utility, and usability of a PIREP submission and retrieval concept that uses VHF radio, cloud computing, and artificial intelligence (AI) technologies. In flight, pilots were able to submit and retrieve PIREPs without talking to an air traffic controller or a flight service specialist. Instead, they used VHF radio to communicate with an automated ground station (AGS) via a voice-user interface. On the ground, pilots were also able to retrieve the experimental PIREPs submitted within the two study locations via a website and a mobile app in three different modes: audio playback, voice-to-text transcription and plain text. This POC study successfully demonstrated the application of already existing as well as state-of-the-art off-the-shelf technologies as one potential way to modernize the current PIREP system and improve its resiliency.

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List of Abbreviations

Abbreviation	Term
ADDS	Aviation Digital Data Service
ADS-B	Automatic Dependent Surveillance-Broadcast
AGS	Automated Ground Station
AI	Artificial Intelligence
API	Application Programming Interface
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
AWS	Amazon Web Services
ATO	Air Traffic Organization
CAMI	Civil Aerospace Medical Institute
CbTOPS	Cloud-Based Testing, Operations, Performance, Synergies
Con Ops	Concept of Operations
DNN	Deep Neural Network
FAA	Federal Aviation Administration
FSS	Flight Service Station
GBS	Ground-Based Station
KOKC	Will Rogers World Airport
LLWS	Low-Level Wind Shear
MSL	Mean Sea Level
NAS	National Airspace System
NLP	Natural Language Processing
NTSB	National Transportation Safety Board
PANN	Nenana Municipal Airport
PIREP	Pilot Reports
POC	Proof-of-Concept
PTT	Push to Talk
SWAT	Special Weather Action Team
UA	Routine PIREP
VHF	Very High Frequency
VTT	Voice-to-Text
WER	Word Error Rate

Abstract

Pilot reports (PIREPs) are reports describing in-flight weather conditions submitted by pilots that provide crucial weather information to other pilots for pre-flight and in-flight planning. The current PIREP system is antiquated, prone to error, and has been identified as a safety concern according to a 2017 National Transportation Safety Board Special Investigation Report. This paper describes the results from a proof-of-concept (POC) study investigating the feasibility, utility, and usability of a PIREP submission and retrieval concept that uses Very High Frequency (VHF) radio, cloud computing, and artificial intelligence (AI) technologies. In flight, pilots were able to submit and retrieve PIREPs without talking to an air traffic controller or a flight service specialist. Instead, they used VHF radio to communicate with an automated ground station (AGS) via a voice-user interface. On the ground, pilots were also able to retrieve the experimental PIREPs submitted within the two study locations via a website and a mobile app in three different modes: audio playback, voice-to-text transcription and plain text. This POC study successfully demonstrated the application of already existing as well as state-of-the-art off-the-shelf technologies as one potential way to modernize the current PIREP system and improve its resiliency.

Keywords: Pilot weather reports (PIREPs), Aviation weather, Voice-user interface, Cloud computing, Natural Language Processing (NLP), Artificial Intelligence (AI)

Introduction

The lack of sufficient number and high-quality pilot reports (PIREPs), or reports submitted by pilots describing observed in-flight weather conditions, has been identified as a safety issue by the National Transportation Safety Board (NTSB) (NTSB, 2017). It became the Federal Aviation Administration (FAA) Air Traffic Organization's (ATO's) Top 5 issue in 2018. PIREPs provide timely and sometimes critical weather information for pre-flight planning and in-flight, for avoiding weather hazards. Pilots are not the only ones who use PIREPs. Air traffic controllers use PIREPS to make decisions that support safety and improve the flow of air traffic. Meteorologists use them to validate forecasts and issue warnings, if necessary. An increase in quantity and quality of PIREPs would result in a safer National Airspace System (NAS). According to an NTSB recommendation, "PIREPs must be numerous, accurate, and made available quickly in the NAS to be effective" (NTSB, 2017). As weather is often dynamic, accurate and timely information is critical for the safety of flight operations.

Today, the PIREP system is (a) antiquated, (b) prone to errors due to its outdated federated system's architecture, (c) incompatible with busy cockpits and air traffic control operations, and (d) has no resilience. Abundant data exist that identify the PIREP system's shortfalls. However, no empirical data exist showing diversity of solutions that are vetted, compared, tested, and evaluated in an operational environment are currently available to support data-driven decision-making within the FAA with regards to modernizing the PIREP system.

One way to improve the PIREP system is to bridge the technological gap existing today, by transitioning to an integrated system's architecture that combines the most recent advances in technology with already existing, proven, and widely available technologies (Figure 1). Such approach would (a) provide valuable data, (b) inform decisions in selecting optimal design solution(s) that result in operational improvements, (c) prompt changes in policies and procedures; and (d) ultimately, result in safer flight operations.

Figure 1

Current PIREP System Architecture [left] and Potential Future PIREP System Architecture [right]
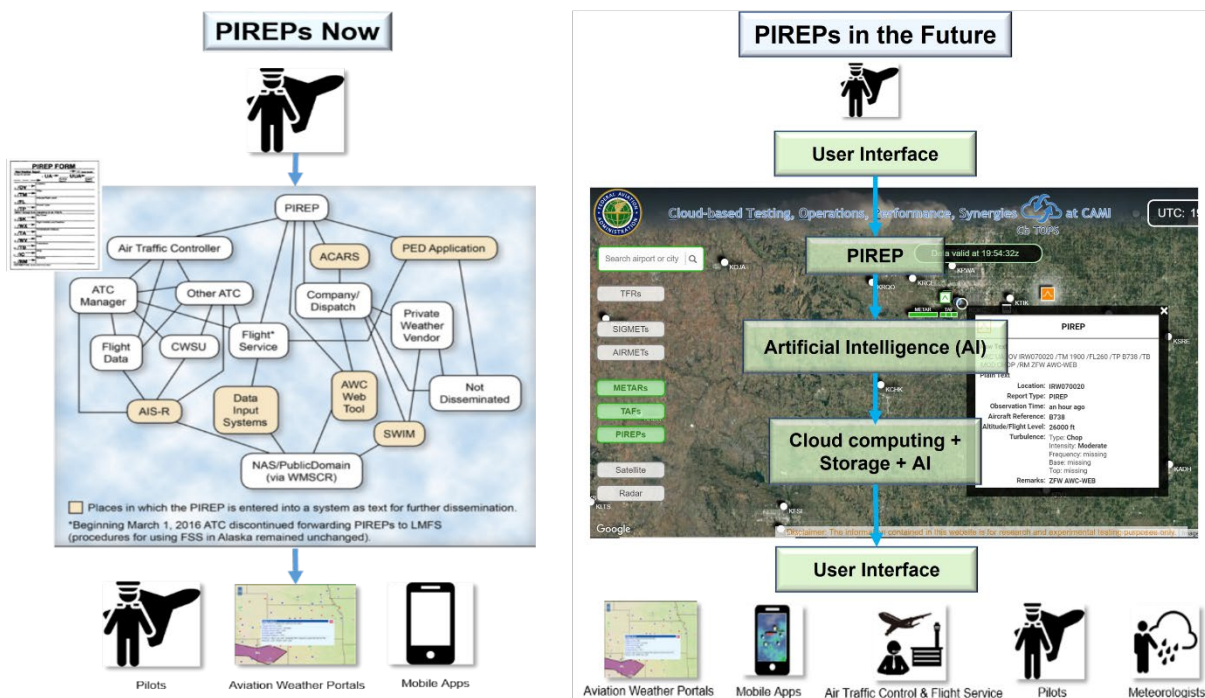
The FAA Civil Aerospace Medical Institute (CAMI) utilized this approach in conducting a proof-of-concept (POC) study of the feasibility, utility, and usability of a PIREP submission and retrieval concept using Very High Frequency (VHF) radio as the transmission/retrieval medium. The concept also utilized cloud computing and artificial intelligence (AI) technologies. The inception of this proof-of-concept study stemmed from the following:

a) The National Transportation Safety Board (NTSB) Special Investigation Report (2017);
b) The ATO adding PIREPs to the ATO's Top 5 Corrective Action Plan for fiscal years 2019 - 2023;
c) The 2020 PIREP summit hosted by CAMI and the MITRE Corporation;
d) The 2020 PIREP End-User Focus Groups Report; and

The FAA Weather Community of Interest PIREP Special Weather Action Team (SWAT) Problem Statements.

Background

A PIREP submission and retrieval concept was developed connecting the flight deck and a ground-based transceiver-and-edge-computer device through VHF voice radio communication. For simplicity, and in the context of this research, the term automated ground station (AGS) was

used in-lieu of the term ground-based transceiver-and-edge-computer device. Using an internet connection, the AGS was connected to a cloud service where PIREPs were processed, stored, and disseminated via the web and mobile applications developed for this research. CAMI requested and received approval from the FAA Spectrum Engineering Team to use 122.0 MHz and 127.075 MHz as dedicated PIREP frequencies for Oklahoma and Alaska, respectively. The licenses to operate on these frequencies were temporary and for the duration of the study (from November 4th, 2022, to April 30th, 2023). In-flight, the pilots and the AGS interacted via a voice-user interface for both submission and retrieval of PIREPs. On the ground, pilots were able to retrieve PIREPs via the web and mobile apps in three different modes: audio playback, voice-to-text (VTT) transcription and plain text.

Research Study Objectives

The objective of this exploratory-in-nature POC research was to examine the feasibility, utility and usability of a PIREP submission and retrieval concept using VHF radio as the submission/retrieval medium and cloud computing and AI technologies as a method for soliciting, processing, storage, retrieval and dissemination of PIREPs.

Research Questions

1. What is the feasibility, utility and usability of a PIREP submission and retrieval concept using VHF radio as the transmission medium for submission and retrieval?
2. What is the feasibility, utility and usability of a PIREP retrieval in plain text, audio recording and voice-to-text transcription on the ground via web and mobile applications?
3. What is the feasibility, utility and usability of a PIREP retrieval in-flight via VHF radio in the form of audio recording?
4. What is the feasibility, utility and usability of using voice as a primary user interface for submittal and in-flight retrieval of PIREPs?

Research Design

Participants

Student pilots, Flight Instructor, General Aviation, Part 135, and Part 121 pilots (see Table 1) flying within the areas specified below were recruited to participate in this research:
- Oklahoma: Will Rogers World Airport (KOKC) and the surrounding area within 50 miles,
- Alaska: Nenana Municipal Airport (PANN) and the surrounding area within a radius of 50 miles.

Participants were compensated for their participation.

Table 1

Participant Demographics

Study Sites	Signed Up / Actually Participated	Type of Operations					
		Student Pilots	Instructor Pilots	GA Pilots	Part 135 Pilots	Part 121 Pilots	Other Pilots
Nenana, AK	56/25	1/0	1/1	19/12	9/8	5/2	21/2
OKC, OK	285/119	30/21	11/7	109/56	5/4	46/25	84/6
Total	**341/144**	**31/21**	**12/8**	**128/68**	**14/12**	**51/27**	**105/8**

Study Sites	PIREP Submissions						
	Total Submitted	Student Pilots	Instructor Pilots	GA Pilots	Part 135 Pilots	Part 121 Pilots	Other Pilots
Nenana, AK	1567	0	13	636	841	51	26
OKC, OK	2335	216	119	1632	13	265	90
Total	**3,902**	**216**	**132**	**2,268**	**854**	**316**	**116**

Study Sites	PIREP Retrieval Calls						
	Total Retrieval Calls	Student Pilots	Instructor Pilots	GA Pilots	Part 135 Pilots	Part 121 Pilots	Other Pilots
Nenana, AK	938	0	0	115	790	4	29
OKC, OK	657	58	7	523	1	67	1
Total	**1,595**	**58**	**7**	**638**	**791**	**71**	**30**

Materials and Apparatus

Participant Documentation and Forms

Electronic versions of the following documents were available upon logging in to their participant accounts (Figure 2) at https://cbtopsatcami.faa.gov/:

- Informed Consent Form (downloadable in PDF format)
- Demographics Form (Appendix A)

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- Feasibility, Utility and Usability Survey (Appendix B)

Figure 2
Participant Account Log-in Page
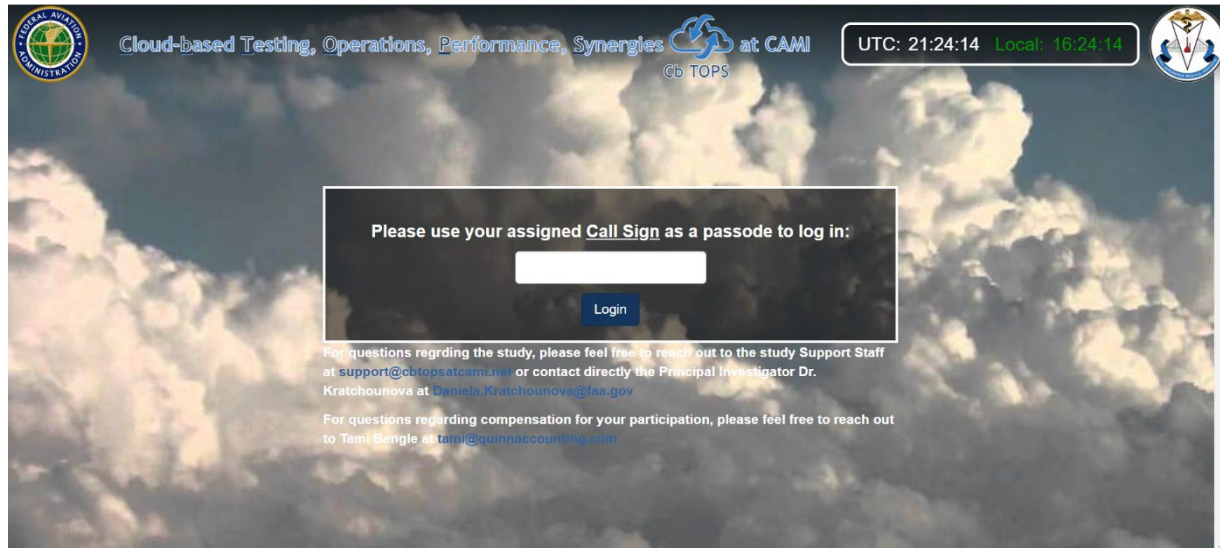
The participants were able to log in to their personal accounts and fill out their bi-weekly surveys as shown in the Cloud-based Testing, Operations, Performance, Synergies (CbTOPS) platform on Figure 3.

Figure 3
Participant CbTOPS Account Page
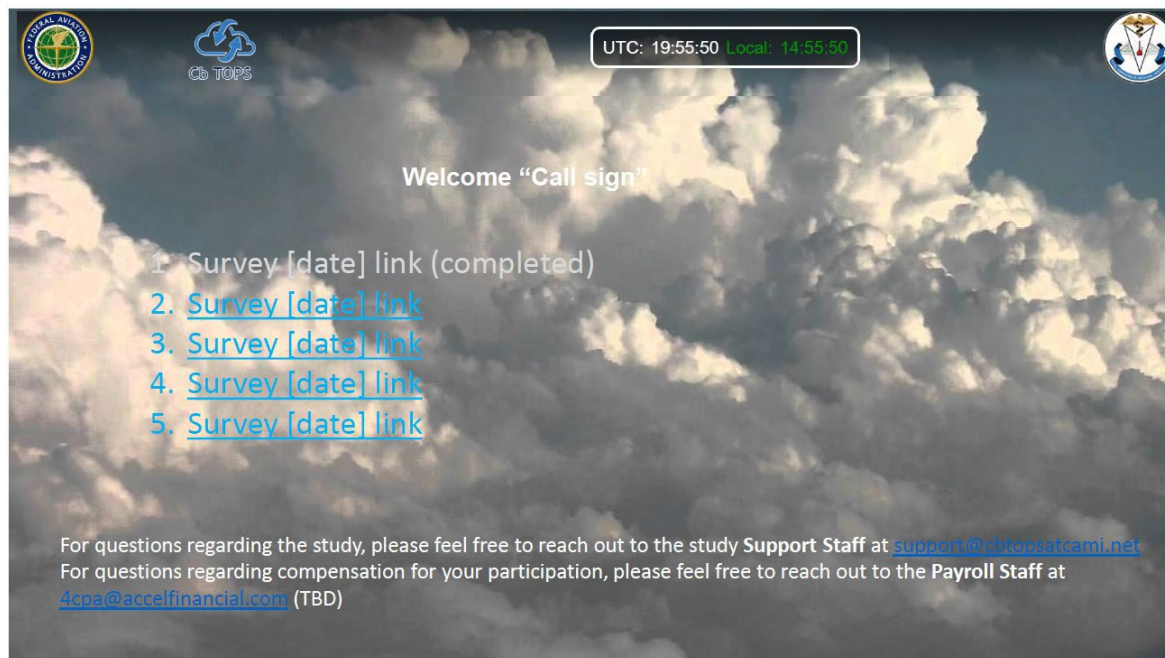
Hardware and Software

The following software was used on CAMI's Cloud-based Aviation Weather Human Factors Research platform:

- Amazon Web Services (AWS) EC2 & S3
- Ubuntu Operating System
- Docker containers
- Node.js
- Nginx and Express.js web server
- PostgreSQL database
- React.js web framework
- Google Maps Javascript application programming interface (API)

The following AGS hardware and software was used for this research:

- AGS 120 VAC Power supply
- Yaesu FTA series handheld VHF airband transceiver and connecting cables
- Yaesu FTA series cradle and 120 VAC charger/power supply
- VHF Antenna, mounting hardware and connecting cable
- Computer peripherals (mouse, keyboard, HDMI monitor, uninterruptible power supply), user-supplied
- Google AIY-voice-kit speech-to-text utilities and libraries (some components implemented under open-use Apache license)
- Python (see python.org for license information, open source)
- AGS (Authorized use by ConnectSix, LLC)

An internet-to-cockpit connection was implemented through the AGS that included an internet-connected edge-compute device and aviation-band VHF transceiver. The transceiver's audio was captured by the edge-compute device. The edge-compute device accessed an internet-based VTT tool to enable immediate transcription of received pilot voice. Using the returned transcription, the AGS interacted with the pilot participants to capture either an entry or a retrieval of PIREPs. Importantly, the VTT model used in this study was not optimized for typical aviation language, such as the phonetic alphabet, aircraft location reporting, certain weather phenomena, etc. Further, the VHF communication link, between aircraft and the AGS, was not enhanced.

Procedures

The POC study was conducted over the period of six months beginning on November 4, 2022, and ending on April 30, 2023. The participants signed up in for the study on the dedicated website and provided the necessary information to receive compensation for their participation on bi-weekly bases. A confirmation email with their CbTOPS login credentials was sent to each

participant after signing up. Those credentials included their assigned call sign**.** Participants in the Oklahoma City area were assigned a call sign containing the name "Sooner State" and a three-digit unique identifier, e.g., "*Sooner State 546.*" The participants in the Nenana, AK area were assigned a call sign containing the name "Last Frontier" and a three-digit unique identifier, e.g., "Last Frontier 876."

The sign-up process was considered complete when participants had signed the electronic informed consent form and filled out the electronic demographics' questionnaire. For the duration of this study, participants were encouraged to submit at least one PIREP per flight and retrieve the experimental PIREPs any time they are flying and while within 50 miles of KOKC and PANN. The mobile app developed for the study was available from https://cbtopsatcami.faa.gov/.

Participants were instructed to submit and retrieve PIREPs only outside the airport traffic pattern and during the enroute/cruise phase of flight. Every two weeks from their sign-up date, participants were asked to fill out and submit a short feedback survey posted on their CbTOPS account. A reminder email was sent out to each participant on the day a new survey was posted to their CbTOPS account. Participants were compensated for each submitted PIREP after every two-week period, but only after filling out the bi-weekly survey.

Participants used their assigned call sign (not the aircraft tail number or flight number) to submit and retrieve PIREPs for the duration of this research. If they did not use their call sign submitting PIREPs and CbTOPS credentials to complete the bi-weekly feedback survey, they were not compensated for their participation. The bi-weekly compensation was in a form of either a check or a direct deposit based on the choice participants made during sign-up.

Research/Recruitment Briefing

The participants briefing was available in two formats: narrated video and downloadable PowerPoint/PDF presentation; and was available for viewing on their CbTOPS accounts.

Examples of types of PIREPs

Different types of PIREP examples (FAA Advisory Circular [AC] 00-45H, 2016) similar to those provided below, were included in the participant briefing to encourage participants to submit reports for a range of conditions. This included asking them to provide more "null" ($\emptyset$) or routine PIREPs (UA) if no turbulence or icing with at least "smooth or light" (for turbulence) or "trace" (for icing) conditions exist at the time of filing. In addition, the web and mobile app contained a legend as shown on Figure 4.

Figure 4

CbTOPS Legend
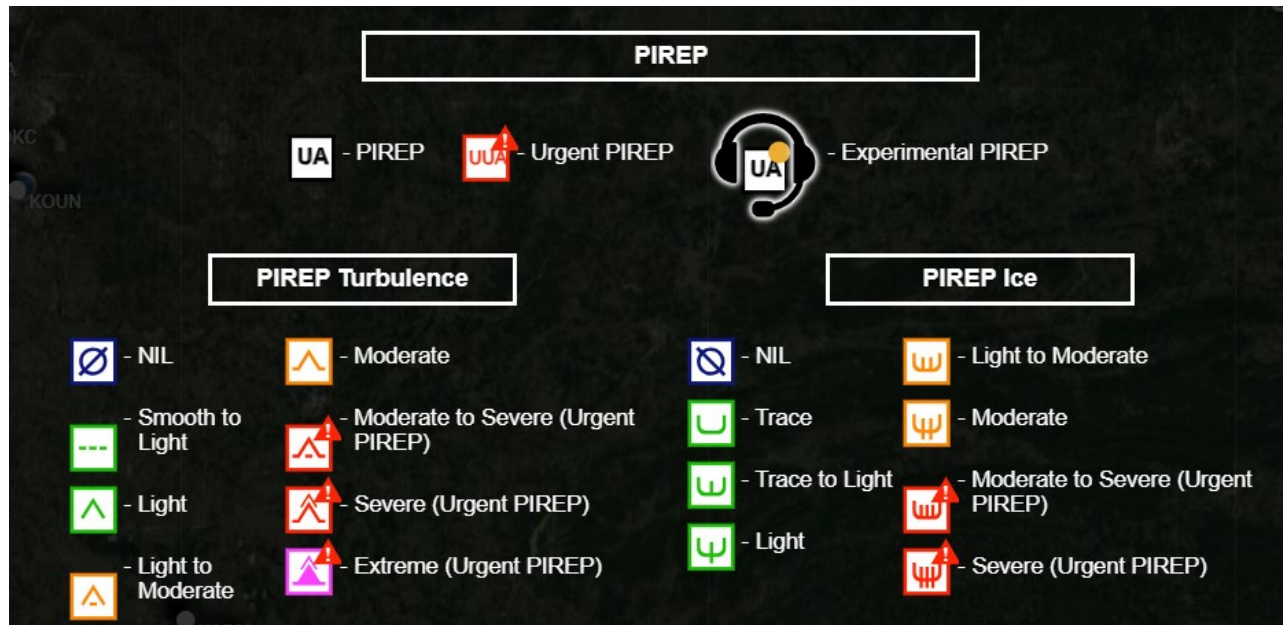
Sky Conditions PIREPs Examples
- Base of broken layer 4,000 ft mean sea level (MSL), top 6,500 ft MSL.
- Base of an overcast layer 10,000 ft MSL, top 11,000 ft MSL, clear above.
- Base of an overcast layer 1,500 ft MSL, top 3,500 ft MSL, base of an overcast layer 23,000 ft MSL.
- Overcast layer, top 8,500 ft MSL.
- Base of a scattered to broken layer 5,000 ft MSL, top 10,000 ft MSL.
- Base of a broken to overcast layer unknown, top 6,000 ft MSL, base of a broken layer 12,000 ft MSL, top 15,000 ft MSL, clear above.
- Base of an overcast layer 6,500 ft MSL, top unknown.
- Base of an overcast layer 6,500 ft MSL, top unknown, remark, in the clouds.

Flight Visibility and Weather PIREP Examples
- Flight visibility 1 sm, base heavy dust storm layer at the surface, top 8,300 ft MSL, clear above, remarks, during climb.
- Flight visibility 0 sm, thunderstorm, heavy rain, hail.
- Flight visibility 2 sm, base of a haze and mist layer at the surface, top 8,300 ft MSL.

Air Temperature PIREP Examples
- Outside temperature minus 12 degrees Celsius.

Wind Direction and Speed PIREP Examples
- Winds from the south at 16 kt.

Turbulence PIREP Examples
- Light turbulence.
- Light turbulence at 4,000 ft MSL.
- Occasional moderate to severe turbulence below 8,000 ft MSL.
- Moderate to severe clear air turbulence at 35,000 ft MSL.
- Negative turbulence between 12,000 ft and 18,000ft MSL.
- Continuous moderate chop at 22,000 ft MSL, negative turbulence between 23,000 ft and 28,000 ft MSL.
- Moderate clear air turbulence above 29,000 ft MSL.

Icing PIREP Examples
- Light to moderate mixed icing, 8,500 ft MSL.
- Light rime icing.
- Moderate rime icing below 9,500 ft MSL.
- Severe clear icing 3,500ft to 6,200 ft MSL.

PIREP Remarks

The remarks section of a PIREP is used to report a phenomenon that is considered important but does not fit in any of the other groups. This includes, but is not limited to, windshear reports, thunderstorm lines, coverage and movement, lightning, sulfur dioxide (SO_2) gas smell, clouds observed but not encountered, and geographical or local descriptions of where the phenomenon occurred. Hazardous weather should be reported first.

Concept of Operations (Con Ops)

Most aircraft today are equipped with a VHF radio, which is the primary communication tool used to file PIREPs via communicating either with a Flight Services Station (FSS) or Air Traffic Control facility. The use of a dedicated radio frequency for submitting and retrieving PIREPs had the potential to provide an additional mechanism for pilots to communicate these reports while reducing congestion on other FSS and air traffic control (ATC) frequencies. Figure 5 shows a high-level system architecture diagram of the concept used for this research.

Figure 5

System Architecture Diagram
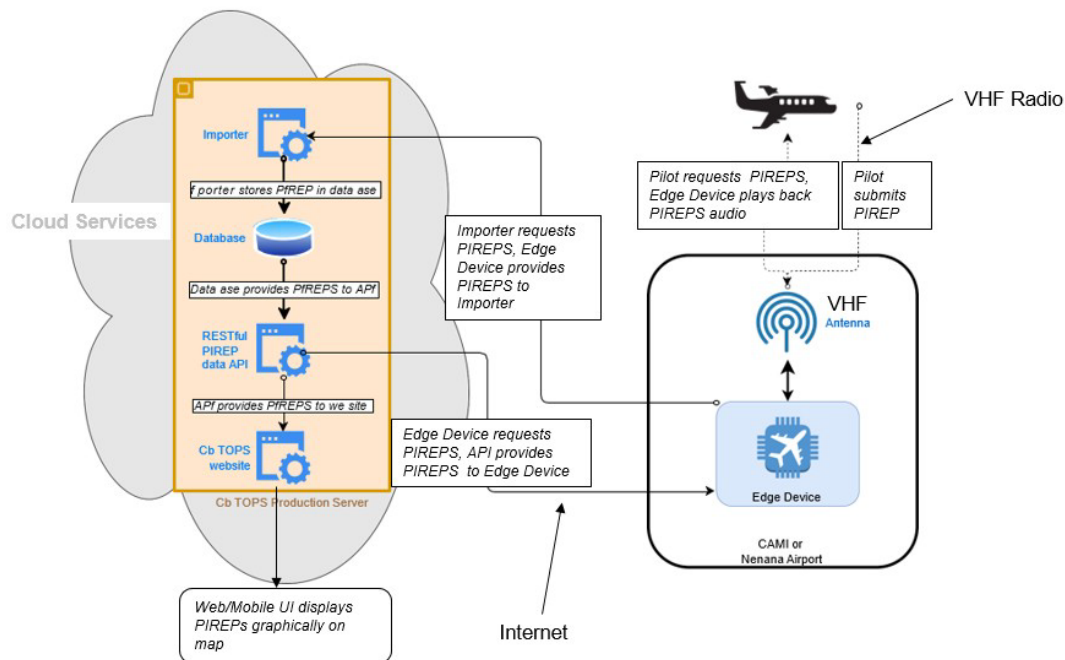
POC Study Con Ops Assumptions

There were two PIREP ground station IDs used for this research:

- "PIREP Watch Oklahoma" and
- "PIREP Watch Alaska."

These station IDs were used by pilots when contacting these ground stations on the assigned discrete frequencies (i.e., 122.0 MHz and 127.075 MHz).

User Interface Design and Functional Requirements

- The system shall recognize the word "PIREP."
- The system shall be able to read back each call sign. There will be a finite set of call signs generated for Oklahoma and Alaska.
- The system shall be able to respond to "cold calls."[1]
- Each call sign shall be recognized at both the beginning and the end of each pilot transmission.
- The system shall be able to understand location and altitude without the pilots having to use "location" and "altitude" as key words. This means that the set of key words needs to include numbers, miles, feet, local time, etc.
- The system shall be able to understand magnitude/intensity of weather phenomena.

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[1] A cold call is a short radio transmission to get the controller's attention.

- The system shall record all the pilot audio from push-to-talk (PTT) push to PTT release without any built-in delays and the recording will include the pauses between utterances.
- The system shall place PIREPs on the map accurately and based on the location description given in the voice-to-text transcription.
- The system shall be able to retrieve PIREPs only within certain distance of airports (i.e., no nav aids will be recognized for this phase of the research).

PIREP Submission

The AGS generated a voice-to-text transcription using available natural language processing (NLP) services as well as an audio recording of the PIREP submitted via VHF radio. Using an internet connection, the AGS sent the text and audio to a cloud service for processing, storage, and display on web and mobile applications. For this POC study, no Automatic Dependent Surveillance-Broadcast (ADS-B) data were used to auto-fill the first five fields of the traditional PIREP form (FAA AC 90-114B, 2019). Instead, pilots provided location and altitude information during the submission process. For payroll tracking purposes, individual participant call signs were used by the participants in the study.

PIREP Submission Voice User Interface

During the study, the following steps and voice-user interface were used by pilots to submit a PIREP. The example below is of a pilot based in Alaska with a call sign "Last Frontier 465." Note, the elements of the voice-user interface shown in [brackets] were optional.

1. Tune the VHF com radio to the appropriate discrete frequency.
2. State the **station ID and their call sign** e.g., "*PIREP Watch Alaska, Last Frontier 465 would like to submit/enter/file a PIREP.*"
    - If the system had difficulties understanding the call sign it would ask the pilot to say again, e.g., "*Aircraft calling PIREP Watch Alaska, please repeat your call sign.*"
3. The system replied: *"Last Frontier 465, go ahead with a request to submit or retrieve PIREPs."*
4. The pilot stated whether they wanted to submit or retrieve PIREP(s).
    - If the pilot did not respond with "enter a PIREP" or "retrieve a PIREP" the system responded with *[Call sign] would you like to file/submit/enter or retrieve pilot reports?*
5. The system would reply: "*[Last Frontier 465] be advised this call is recorded. Please state location for the pilot report.*"
6. The pilot would reply e.g., "*[PIREP Watch Alaska] [Last Frontier 465] I am 10 miles west of Nenana.*"
7. The system would reply: "*[Last Frontier 465] your location was recorded. Please state your altitude.*"
8. The pilot would state e.g., "*[PIREP Watch Alaska] [Last Frontier 465] Four thousand five hundred.*"

9. The system would reply: "[*Last Frontier 465] your altitude was recorded."*
    o If the system had difficulties understanding the location or altitude; it asked the pilot to say again, e.g., "*Last Frontier 465, repeat your location (or altitude)."*
    o If the system was out of range or at the edge of coverage, it waited for 15 sec and said "*PIREP Watch Alaska unavailable please try again after 15 seconds."*
    o The system would reply: "*Last Frontier 465 your location and altitude acknowledged. State observed weather.*"
10. The pilot would say *"[PIREP Watch Alaska] [Last Frontier 465], I have a scattered layer at 7,000 and light turbulence [Last Frontier 465]."*
11. The system would read back the elements of the PIREP and would ask the pilot to add any additional information/remarks e.g., "[*Last Frontier 465] [PIREP Watch Alaska], you reported clouds and turbulence. Please add remarks."*
12. The pilot could add additional weather elements, or if finished stating: "[*PIREP Watch Alaska] No remarks [Last Frontier 465].*" which would terminate the session.
13. Confirmation step: The system would say "*Last Frontier 465 listen to your report for accuracy and state "Affirmative, the PIREP is correct" or "State start over if you would like to re-enter observed weather*".
    o If the PIREP was accurate, the pilot will say: "*Affirmative, the PIREP is correct."*
    o The system would say: "*Last Frontier 465 Your pilot report has been recorded. Thank you."*
    o If the PIREP was not accurately recorded, the pilot could say: [*Last Frontier 465] "Start over."*
    o The system would respond: "*Last Frontier 465 Repeat observed weather or wait for 15 seconds to start a new session."*

PIREP Retrieval

In-flight, the retrieval process involved the pilot using VHF radio to request available PIREPs within a certain geographical area. No timeframe option was available during the proof-of-concept phase of this research. Also, in-flight, the pilots were able to retrieve only the audio recording(s) of the available experimental PIREPs that met the request criteria.

On the ground, by using the web or mobile versions of CAMI's Aviation Weather Human Factors Research Platform at https://cbtopsatcami.faa.gov/, pilots were able to listen the audio playback and view all PIREPs submitted as part of this POC study as experimental PIREPs as well as all available PIREPs in the NAS, at the time of viewing, The experimental PIREPs were displayed with an orange dot at the top right corner of the PIREP icon and a headset graphic surrounding it (Figure 6). The experimental PIREPs were available for retrieval by clicking directly on the icon and in three different modes from the pop-up window (Figure 6) as follows:

1. Audio recording

2. Voice-to-text transcription
3. Plain text

Figure 6

CAMI's Aviation Weather Human Factors Research Platform at *https://cbtopsatcami.faa.gov/*
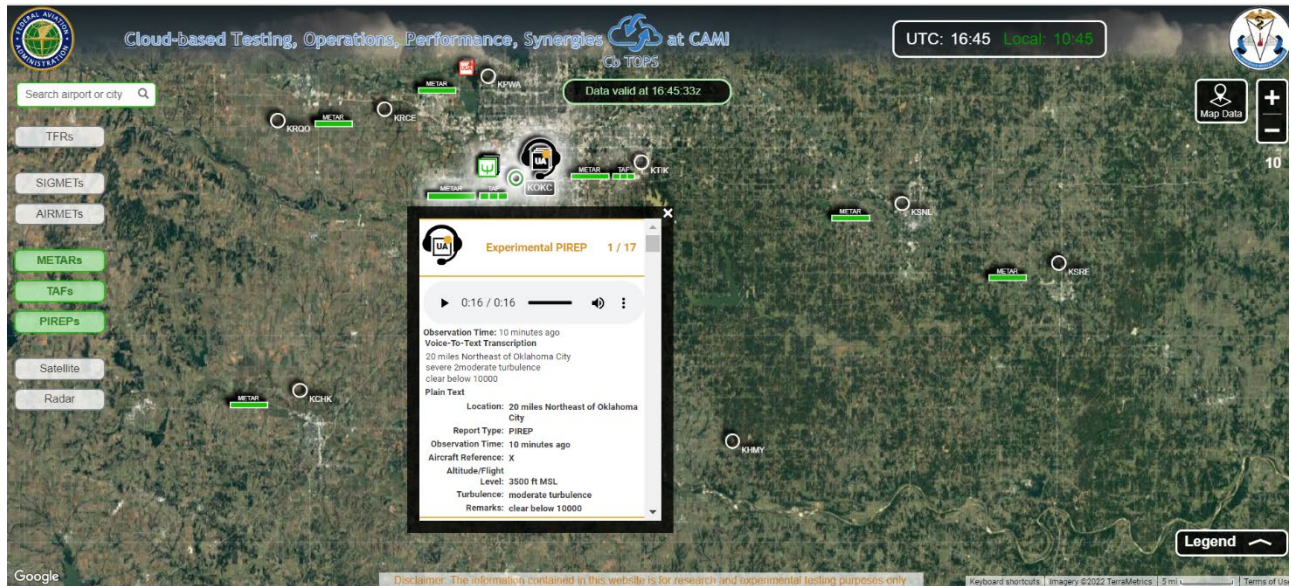
In-flight PIREP Retrieval Voice-User Interface

During the study, the following steps and voice-user interface were used by pilots to retrieve PIREPs. The example below is of a pilot based in Oklahoma with a call sign "*Sooner State 764.*" Note, the elements of the voice-user interface shown in [brackets] were optional.

1. Tune their VHF com radio to 122.0 MHz (Oklahoma) or 127.075 MHz (Alaska).
2. State the **station ID and their call sign** e.g., "*PIREP Watch Oklahoma, Sooner State 764.*"
3. The system would reply: "*Sooner State 764, go ahead with a request to submit or retrieve PIREPs.*"
   - The pilot would state whether they want to submit or retrieve PIREP(s).
   - If the pilot did not respond with "submit a PIREP" or "retrieve a PIREP" the system responded with *[Call sign] would you like to file/submit/enter or retrieve pilot reports?*
4. The pilot would respond*: "Requesting pilot reports within 10 miles of Oke City.*"
5. The system would reply: "*[Sooner State 764] [PIREP Watch Oklahoma] there are 3 experimental pilot reports submitted in the last 3 hours.*" and play **the audio** of all available **experimental only** PIREPs within 10 miles of KOKC.
   - During the study the maximum number of PIREPs that would be provided to a pilot in-flight was 5.

- o If there were no experimental PIREPS in the area, the system will say: "*Sooner State 764 there are no experimental PIREP meeting your request criteria in the last 3 hours.*"
- o The system would play back the available PIREPs from the most recent backwards with an "index of total" (e.g., 1 of 4) and each report's age.

For this POC study, the pilot participants were not able to specify the timeframe of the requested reports via VHF radio and the timeframe was set at 3 hours. However, all PIREPs, both experimental and non- experimental, submitted in the last 6 hours were available on the CbTOPS website and mobile application. Early on, during the research planning phase, the research team believed that it was possible for pilots to also request altitude limits, e.g., "say PIREPS below 15,000 ft." The results of the internal testing and pilot study determined that this feature would not be available for this first phase of this research.

Pilot Study

A pilot study was conducted prior to the main research study. Five pilots were recruited for the pilot study. The pilot study participants represented the population sample(s) as closely as possible. The results of the pilot study were reviewed and modifications to the research plan and the main study were made as necessary.

Results

Submission via VHF Radio

Participants rated PIREP submission via VHF radio as one of the best features of the concept (Figure 7). On a scale of 1-to-5, with 5 being excellent, participants rated submission via VHF radio with a median score 5 for *Usefulness*, 4 for *Ease of Use*, 4 for *Ease of Interpretation*, 4 for *User Experience*, and 4 for *Overall Operational Viability / Practicability*.

Figure 7
Survey Results for Submission of PIREP via VHF Radio

PIREP Submission via VHF Radio

| 1 = Very poor | 2 = Poor | 3 = Adequate | 4 = Very good | 5 = Excellent |
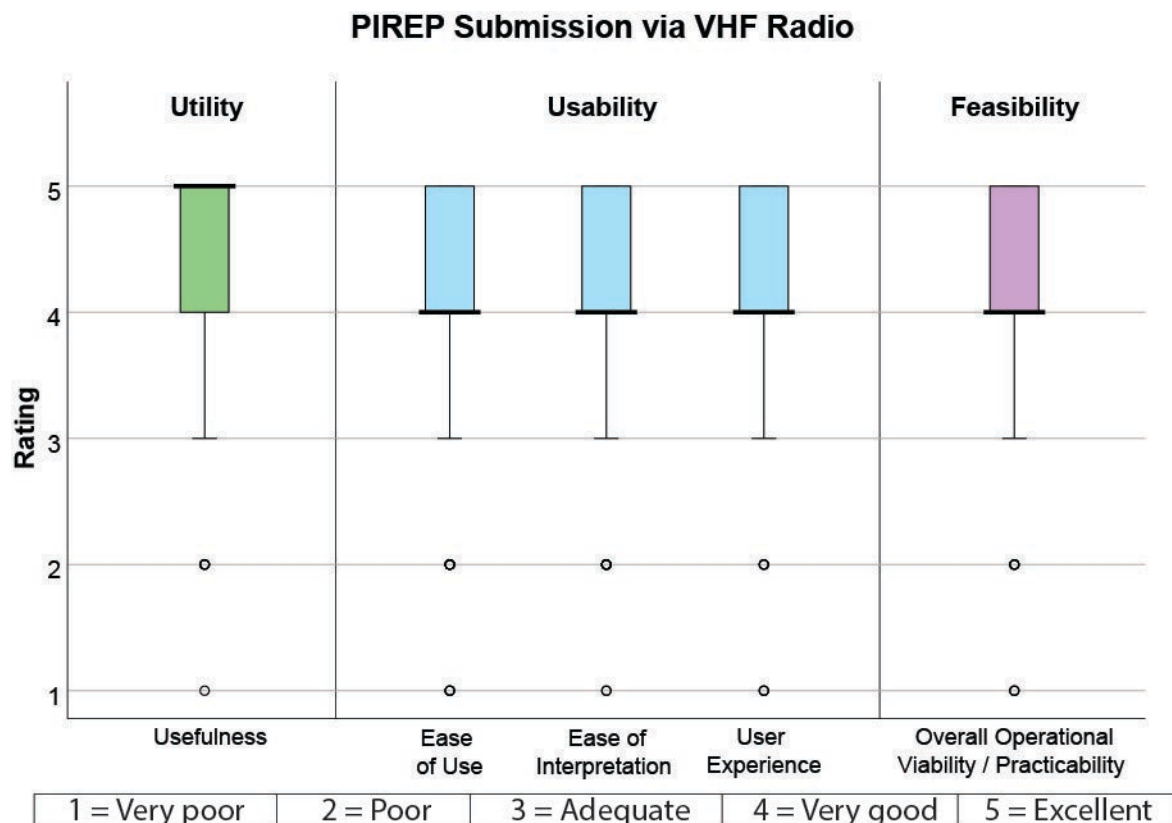
Participants noted that after a short initial learning period the system was straightforward and easy to use (see Appendix C for a complete collection of feedback on this feature). For example:

> *"The more I use the system, the more impressed I am. I think any initial issues for me can probably be attributed to too great a distance from the antenna for good reception. As long as I'm flying "in range" I can easily submit a PIREP in less than two minutes without any hiccups. The system hears me and understands me just fine. I think that's great to encourage the general flying public to submit more PIREPS."*

However, there were also areas requiring improvement noted by participants throughout the study period relating to the system usability, such as when they needed to restart the process:

> "*The system seems to easily identify voice inputs correctly when it is able to receive. When the system misses one input, it can be difficult to get the process started again.*"

Overall, participants appreciated the potential utility of this experimental system and were supportive of its future implementation:

> *"This concept seems very practical and could be very beneficial to the national airspace system. It is very easy to use once you understand the order in which the computer*

expects you to say things. It is very easy to interpret what it is asking me as I go through the prompts."

"I really like the system. At first, I was skeptical of its ease of use, but after a few practices with it, I find that it is really easy to give and retrieve PIREPs. It's often difficult to get in touch with ATC on congested frequencies, especially when the weather is bad, so this would be a perfect way to be able to capture that weather data and provide it to pilots in a way that will not be a burden on busy air traffic controllers. Especially for VFR traffic, a pilot is more likely to call the automated system rather than try to contact a ARTCC center controller for PIREPs."

Retrieval via VHF Radio

Using the VHF radio call function, participants were able to retrieve the audio recordings of recently submitted PIREPs while in-flight and rated this feature favorably (Figure 8). On a scale of 1-to-5, with 5 being excellent, participants rated the retrieval via VHF radio with a median score of 5 for *Usefulness*, 4 for *Ease of Use*, 4 for *Ease of Interpretation*, 4 for *User Experience*, and 4 for *Overall Operational Viability / Practicability.*

Figure 8
Survey Results of Retrieval of PIREPs via VHF Radio
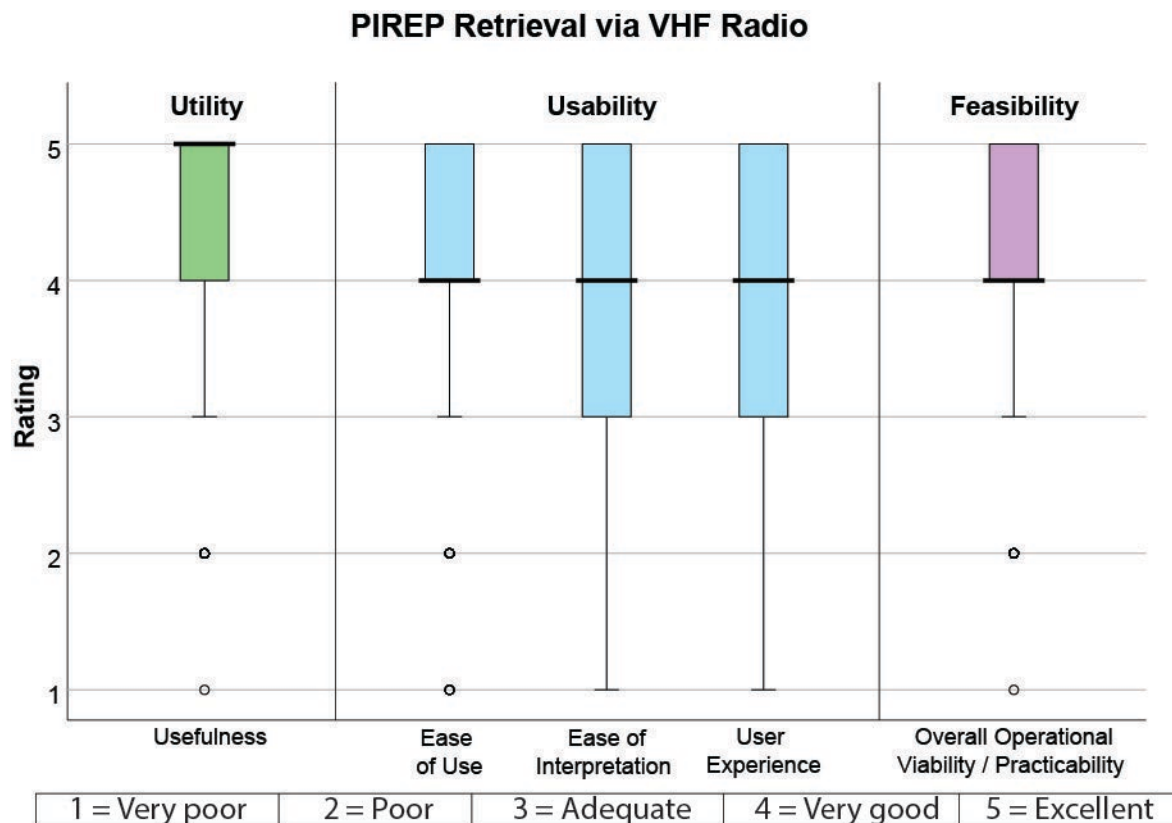
Participants appreciated the ability to listen to an audio recording of submitted PIREPs (see Appendix D for a complete collection of feedback on this feature). They noted:

> "*I like how the system plays back the recording of the pilot's PIREP. This way, the pilot retrieving the PIREP can hear in the 'first person' what the reported weather was, versus an air traffic controller writing it down and explaining it 'secondhand' or 'third hand'*"

> "*I appreciate hearing the actual recording. So much can be gleaned from the pilot's voice.*"

Ratings for retrieval via a VHF radio call were slightly lower than ratings for submission via a VHF radio call, likely due to the system having difficulties, at times, correctly identifying the location for which a pilot was requesting PIREPs. For example:

> "*PIREP retrieval is very helpful for any pilot operating in all environments. The voice recognition software had a little bit of difficulty recognizing the station I was asking about, but that could have happened for a variety of reasons.*"

> "*Great to hear reports in pilots own words and voice. System seems to still have some trouble with locations.*"

Participants viewed this component as essential, noting:

> "*The PIREP retrieval is just as important as the PIREP submissions in my opinion. This will enable pilots to get weather updates even when the ARTCC[2] frequencies are crowded during periods of marginal weather. It very easy to use and it is a huge plus to be able to hear the audio file from the pilot submitting the PIREP firsthand.*"

Audio Playback Retrieval via CbTOPS Website or Mobile App

Using the web or mobile app, participants were able to retrieve the audio playback for individual experimental PIREPs from the pop-up dialog box, by clicking on a PIREP icon from the map (Figure 9). Participants rated this feature as one of the best features of the concept. On a scale of 1-to-5, with 5 being excellent, they rated it with a median score of 5 for *Usefulness*, 5 for *Ease of Use*, 4 for *Ease of Interpretation*, 4 for *User Experience*, and 4 for *Overall Operational Viability / Practicability*. In particular, participants favorably commented on the utility of being able to listen to PIREPs through the web or mobile apps during pre-flight planning (see Appendix E for a complete collection of feedback on this feature). For example, participants noted:

> "*I like that I can hear the pilots PIREP from the ground and be shown the exact location on the map. Very practical in the future when it can be integrated on the weather camera site.*"

> "*The graphical interface is excellent. Being able to click on the area where I will be flight planning and listen to the firsthand account is really nice. This could really improve*"

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[2] Air Route Traffic Control Center

aviation safety with regard to flight planning and weather avoidance. A pilot only gets half of the story by looking at prognostic charts and radar/satellite images prior to flying. This user interface is great if it could be rolled out for everyone to use."

"*This is perhaps the glowing gem of the retrieval system thus far. Very useful in preflight preparation!*"

"*I was sitting trying to make a decision on my go/no-go the other day and I thought to myself, "wow, this really would be incredibly beneficial to have this as a legal means of weather." Because the clouds were overcast 1,500 and I wanted accurate temp readings.*"

Figure 9
Survey Results of Retrieval of PIREP Audio via Website or Mobile App
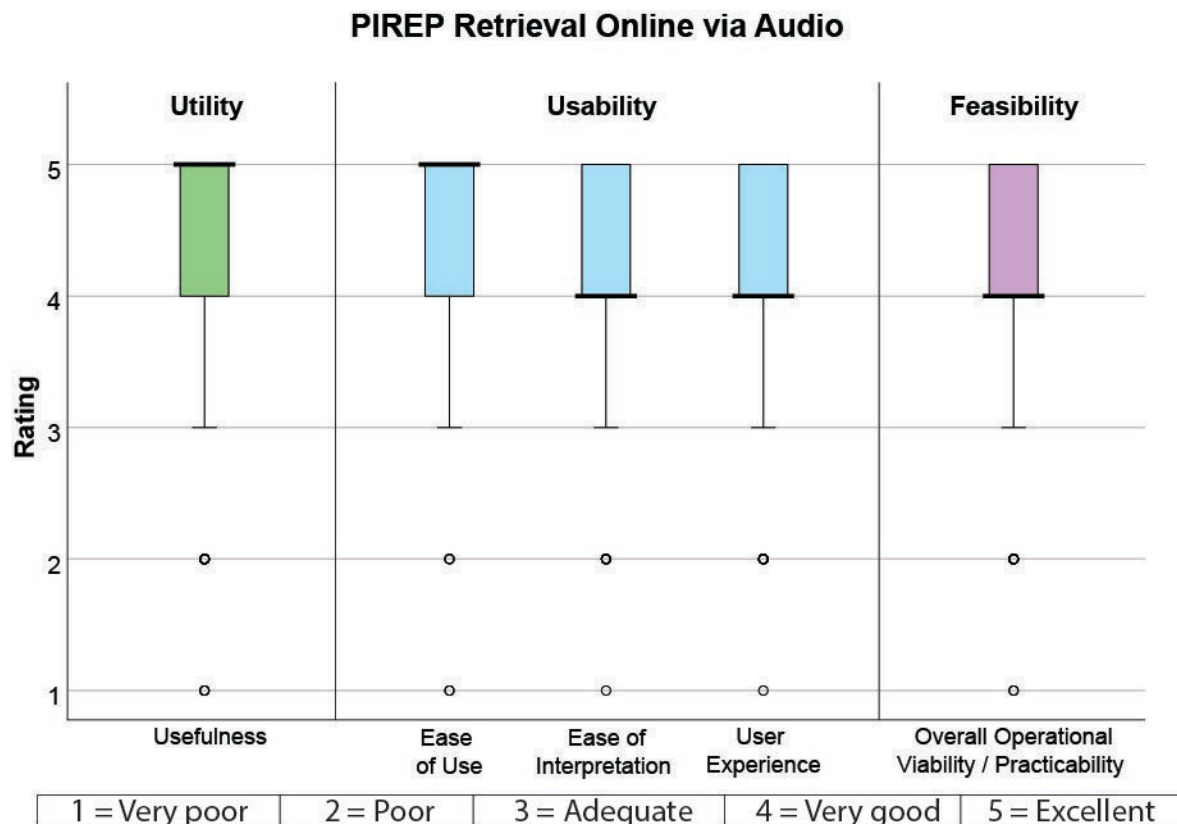
VTT Transcription Retrieval via CbTOPS Website or Mobile App

Participants were also able to retrieve the voice-to-text transcription of individual PIREPs via the web or mobile apps from the pop-up dialog box by clicking on an experimental PIREP icon from the map. Overall, participants rated PIREP retrieval via VTT transcription favorably, though this was the lowest rated feature of the concept (Figure 10). On a scale of 1-to-5, with 5 being excellent, participants rated the retrieval via VHF radio with a median score of 4.5 for

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Usefulness, 4 for *Ease of Use*, 4 for *Ease of Interpretation*, 4 for *User Experience*, and 4 for *Overall Operational Viability / Practicability.*

Figure 10

Survey Results of Retrieval of PIREP Voice-to-Text Transcription via Website or Mobile App

PIREP Retrieval Online via Voice-to-Text Transcription

| 1 = Very poor | 2 = Poor | 3 = Adequate | 4 = Very good | 5 = Excellent |
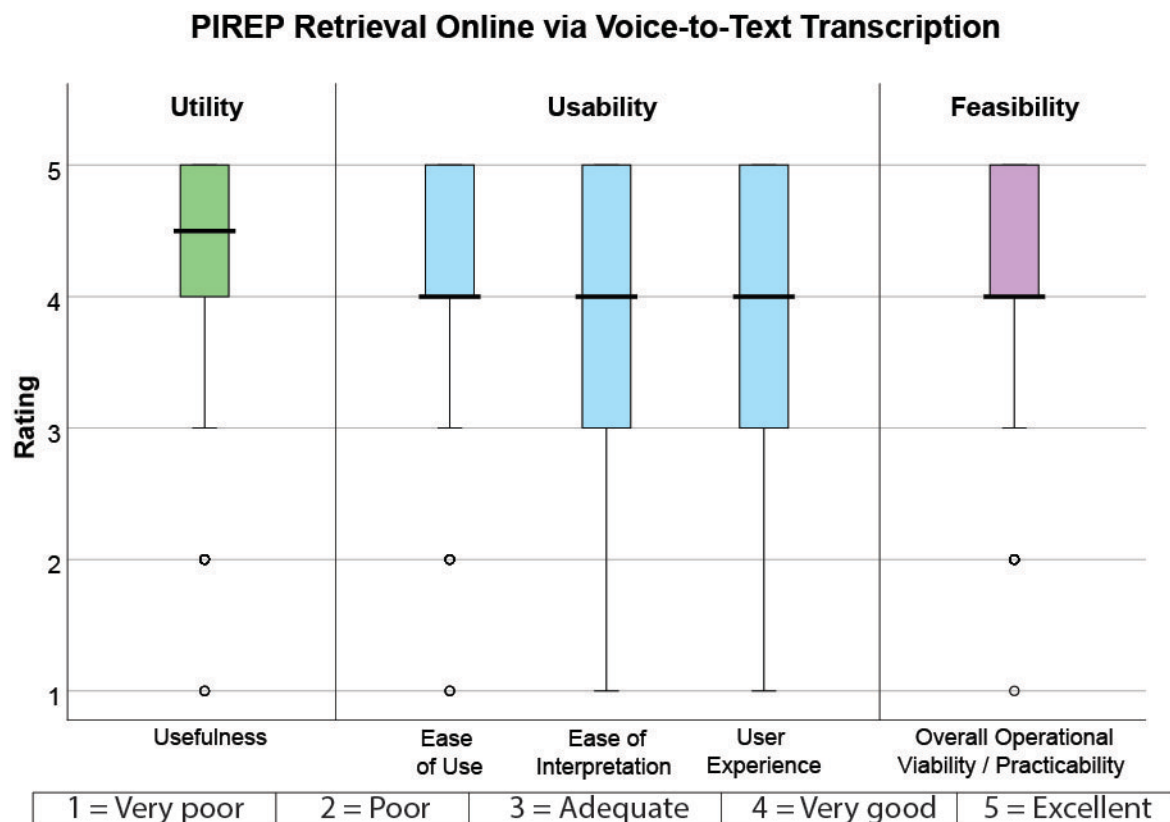
While participants largely viewed this feature positively, negative user feedback centered on the limitations in the accuracy of the voice-to-text transcriptions (see Appendix F for a complete collection of feedback on this feature). For example:

> "*Voice to text transcriptions is not always accurate as to what was stated. Interpretation of some words seems to be dependent on the proper language used in giving the PIREP. If the pilot does not have good diction and pronunciation of some words, the translation seems to be off. I see a need for improvement with the interpretation to text.*"

> "*The system has a difficult time converting voice to text for airport and city names if they are unique.*"

Still, users commented that they appreciated the voice-to-text transcription as a useful means of retrieving PIREPs. For example, participants noted "*The voice to text is probably the most useful part of the system. Although the transcription is very inaccurate,*" and "*If the transcription becomes more accurate, this will be my preferred way to receive the PIREPS and can more easily by integrated into the current NAS and pilot app systems.*"

Plain text Retrieval via the CbTOPS Website or Mobile App

Finally, participants were able to retrieve the individual PIREPs in plain text via the web or mobile apps from the pop-up dialog box by clicking on an experimental PIREP icon from the map. Overall, participants rated the PIREP retrieval via plain text comments favorably (Figure 11). On a scale of 1-to-5, with 5 being excellent, participants rated this feature with a median score of 4 for *Usefulness*, 4 for *Ease of Use*, 4 for *Ease of Interpretation*, 4 for *User Experience*, and 4 for *Overall Operational Viability / Practicability.*

Pilots reported limitations of the plain text retrieval function that were related to the accuracy of voice-to-text transcription at the AGS level (see Appendix G via the web or mobile apps from the pop-up dialog box by clicking on an experimental PIREP icon from the map). Given pilots' familiarity with plain text format already, some reported that this would be their preferred means of retrieving PIREPs if the transcription accuracy were improved. For example:

"*As long as the text is translated correctly, it is a quicker method to retrieve the PIREP.*"

"*I actually think this this is the best way to retrieve the data.*"

"*The accuracy of the plain text needs to get better. I listen to various pilots talking and leaving PIREP. Some speak clearly and use normal terminology; others are not so clear and use nonstandard descriptions of weather and associated phenomena. More pilot training and experience will yield better results in the long run.*"

Figure 11

Survey Results of Retrieval of PIREP Plain Text via Website or Mobile App
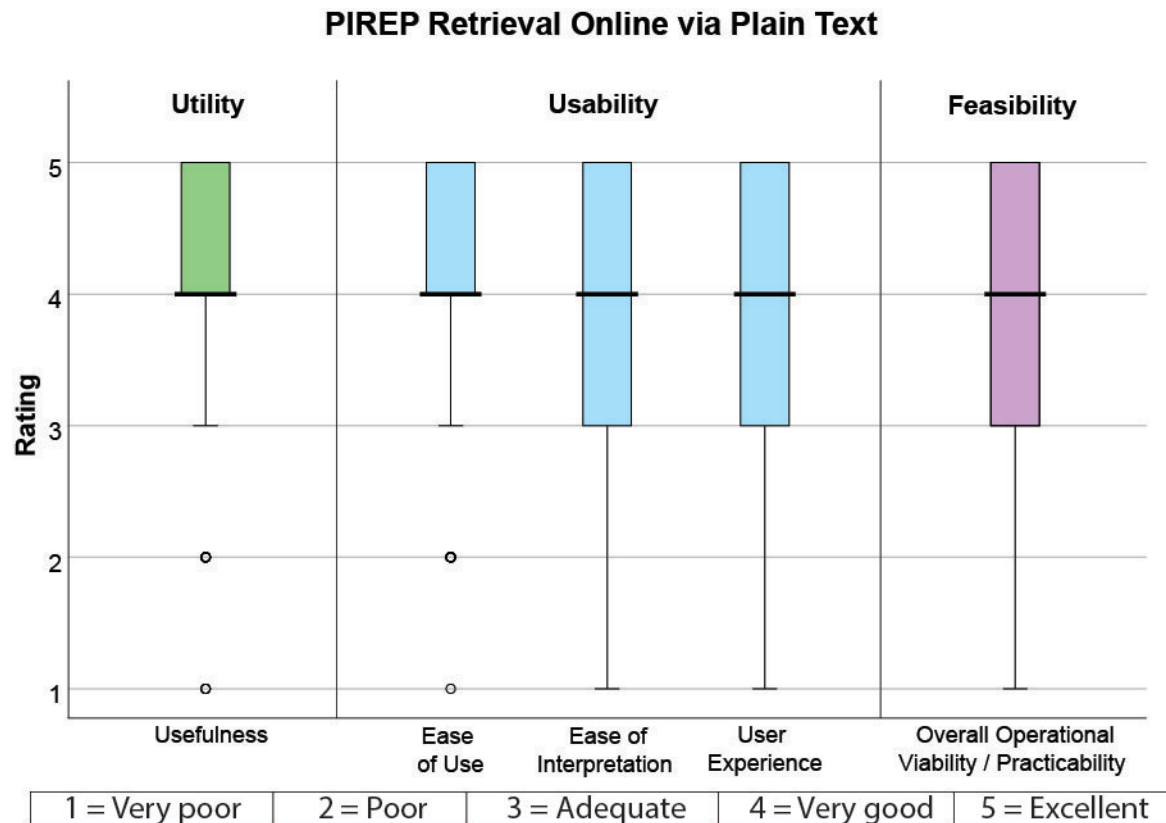
Observed User Ratings Changes over the Course of the Study

To assess how user ratings changed over time, the number of surveys collected during 6-month data collection period was divided into 6 equal parts. Next, the first 1/6th of the surveys were compared to the final 1/6th. Scores largely stayed consistent. However, looking at the plots (Figures 12 - 16), the ratings became less dispersed towards the end of the study. Similarly, the overall ratings' spread showed a smaller range between the extreme values indicating less scattered data. Reduction in the number of outliers was also observed. The median score for utility was rated the highest score of 5 for (a) submission via VHF radio and (b) retrieval via web audio component in both, the first and final samples therefore, indicating a potential ceiling effect. Other features did see an increase in utility ratings over time, including (a) retrieval via VHF radio and (b) retrieval via voice-to-text transcription. However, a decrease in median utility rating from 4.5 to 4 across time was observed for the retrieval via plain text (Figures 12 - 16).

Figure 12

Submission via VHF Radio – First 6th [left] vs Final 6th [right]
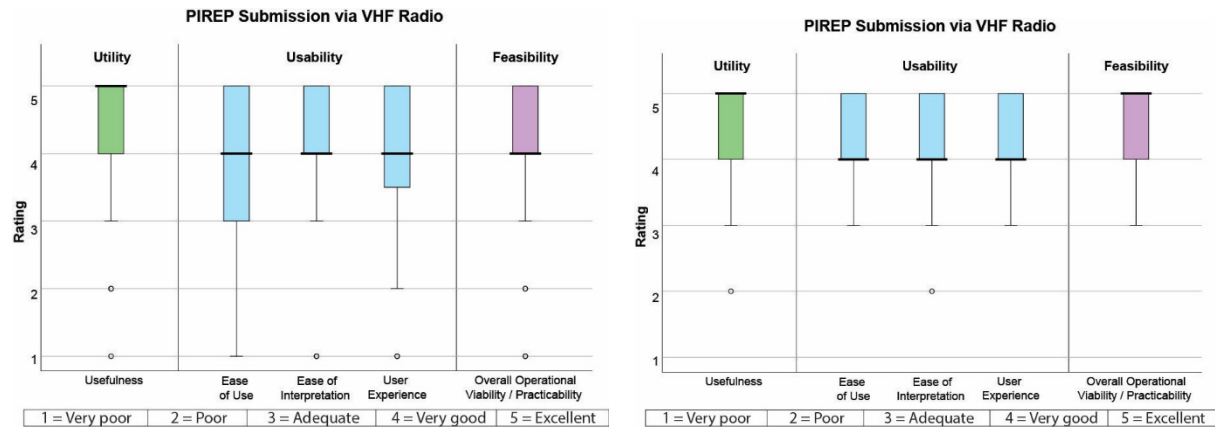
Figure 13

Retrieval via VHF Radio – First 6th [left] vs Final 6th [right]
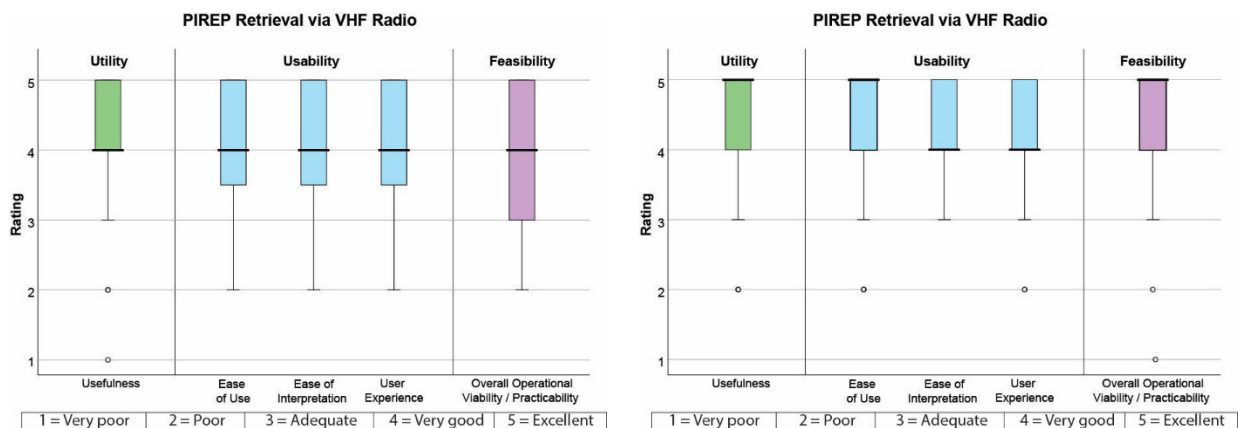
Figure 14

Retrieval Online (Audio Playback) – First 6th [left] vs Final 6th [right]
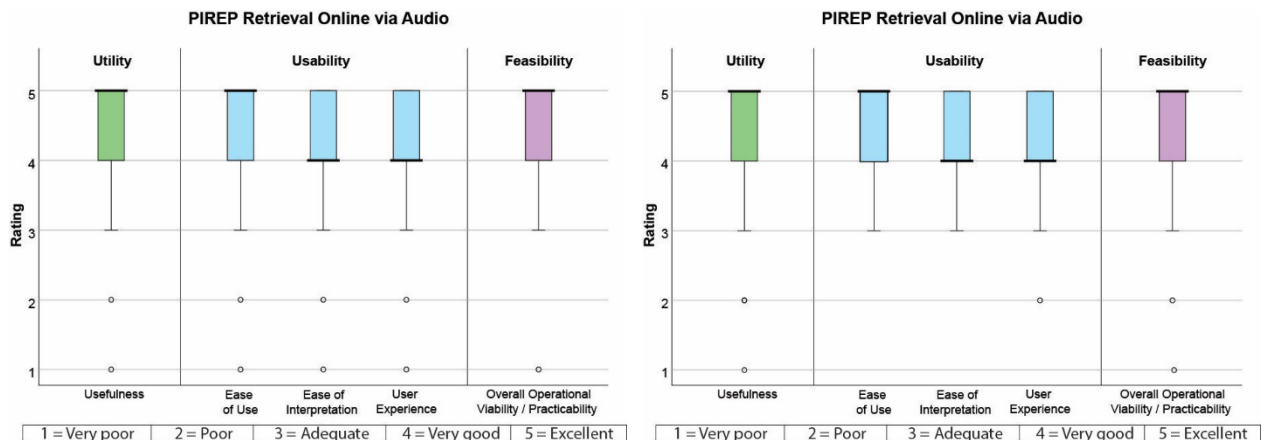
Figure 15

Retrieval Online (VTT Transcription) – First 6th [left] vs Final 6th [right]
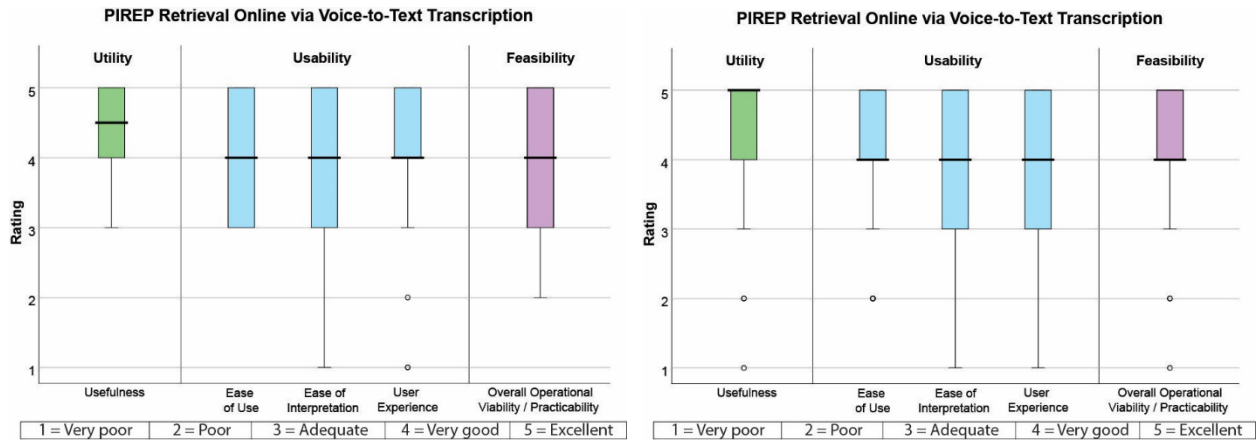
Figure 16

Retrieval Online (Plain Text) – First 6th [left] vs Final 6th [right]
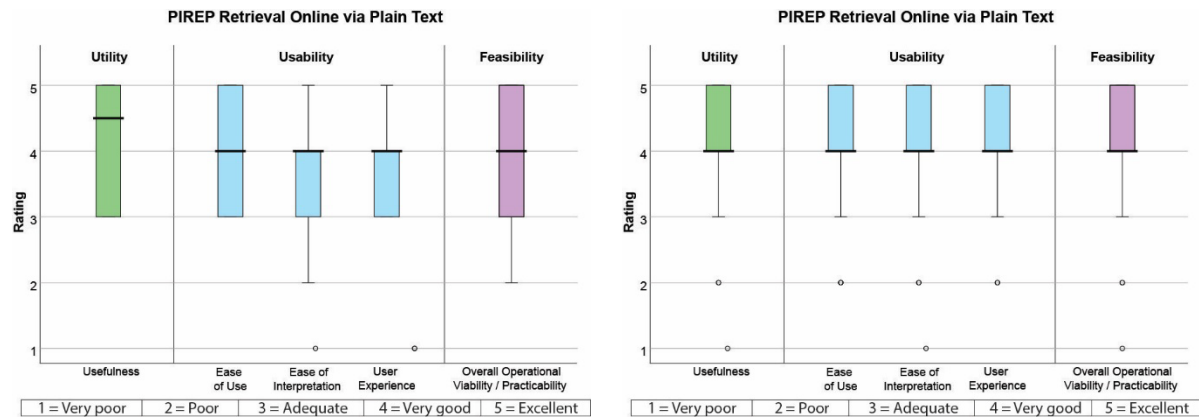
Accuracy of VTT

To assess the accuracy of the VTT transcription by the NLP and other VTT tools (e.g., entity matching) used during the study, a sample of the recorded audio and VTT transcriptions were analyzed by the research team. First, 42 PIREPs were selected. The selection was restricted to a period of time towards the end of the study (March – April 2023). PIREPs were chosen to ensure the sample included a range of different PIREP elements in each report. The sample also aimed to include PIREPs that contained the type, intensity, frequency, etc. of the reported phenomena.

The audio from the 42 sample PIREPs was then transcribed by hand, and used as a benchmark (i.e., a 100% accurate human transcription) to compare to the VTT transcription collected and processed during the study. The research team used a scoring scheme to rate the

accuracy of the transcription, going through each PIREP individually. The weighted scoring scheme consisted of 8 different categories of PIREP elements that were assigned either a weight of "1" for standard reporting information or "2" for critical weather information as follows:

1. Weight of "1":
   a. Sky Conditions,
   b. Weather,
   c. Temperature,
   d. Winds,
   e. Remarks.
2. Weight of "2":
   a. Position/Location,
   b. Altitude/Flight Level,
   c. Turbulence
   d. Icing.

Within each category, there could be multiple components to score. For example, the possible combinations for the Position/Location category could include at most 4 different pieces of information (e.g., airport, distance to airport, cardinal directions, and units of measure) to provide a maximum score of 4/4, which was then multiplied by 2 for the category weight. Similarly, information about icing could have a maximum score of 3/3 for type (e.g., rime), intensity (e.g., trace, light, moderate, severe), and altitude (e.g., base/tops) which was then multiplied by 2, accounting for category weight. For each component that was mis-transcribed in comparison to the human transcription, 1 point from the maximum score was deducted from the relevant category. For the 42 sample PIREPs, the average weighted accuracy of the VTT transcription was 90.2%, indicating overall positive performance. In comparison, the unweighted average accuracy score for the same sample was 88.6%.

Accuracy of Parsing VTT Transcription into Plain Text

To assess the accuracy of the method used during the study of parsing VTT transcription into plain text, a scoring scheme for the parser's performance was developed. The scoring scheme was designed to be as simple as possible, but also account for the varying degrees of success that a single parsing attempt can achieve. To score a transcription, the number of unique observation types (e.g., wind, temperature, sky condition) were counted. If a transcription contained two different observations of the same type, it was still counted as one. Each observation type was given a score as follows:

- Two points for a complete and accurate parsing of the original VTT transcription,
- One point for a partial parse or a complete parse containing extra irrelevant text,
- Zero points were given if the observation type was not parsed from the original VTT transcription,
- One point was subtracted from the score if the parsed text was misleading or

wrong.

If the resulting score happened to be negative, it was rounded up to zero. To calculate the final percent accuracy, the score was divided by the total number of observation types multiplied by two. For observation types that had multiple components, such as intensity, bases or tops altitude, and subtype; more emphasis was placed on getting the subtype and intensity correct. For example, if a transcription reported "light chop at 15,000 feet," and the parser only parsed "light chop," full points were awarded for that observation type. Similarly, the parser was built on the assumption that there would be only one observation of each type. Therefore, if the original text had more than one observation for a particular type, and the parser correctly parsed at least one of the observations; full points were awarded for that observation type. Based on the scoring scheme described above, the parser's performance was assessed against both the automatic NLP VTT recorded during the study and the transcription - by hand - conducted by a person listening to the raw audio. For automatic transcriptions the average accuracy was approximately 54%. For human created transcriptions the accuracy was approximately 60%.

Discussion

PIREP Submission via VHF Radio Feasibility, Utility, and Usability

The overall feasibility, utility, and usability of the PIREP submission via VHF radio system was viewed favorably, as shown by participants' ratings across all metrics in the survey (Figure 7). This component of the system was enthusiastically supported and was tied with the PIREP retrieval via website audio as the most highly rated system component. Overall, users praised the feasibility and utility of the system, suggesting that a widespread adoption of this system would encourage more pilots to submit PIREPs.

Open-ended survey feedback did provide areas for improvement related to the submission component (Appendix C). For example, most noted complaints regarding the submission process were typically related to weak signal strength, which is further discussed below. However, while the overall ratings of the usability and user experience of this submission process were high, a few comments noted that it can be time consuming to start over in the submission process if the system was unable to interpret their call sign. Participants also noted that after a short initial learning period the system was straightforward and easy to use.

PIREP Retrieval via VHF Radio Feasibility, Utility, and Usability

Based on the participants' feedback, the process of PIREP retrieval of via VHF radio had high feasibility, utility, and usability ratings (Figure 8). Participants reported that it was simple and straightforward to retrieve PIREPs with this method and appreciated the ability to retrieve PIREPs via radio if they did not have internet connection onboard. However, retrieval of PIREPs via VHF radio had slightly lower scores for usability in comparison to submission via VHF radio and retrieval of PIREP audio playback via the web and mobile app. In general, participants found the retrieval process relatively easy to use but noted a few more issues related to *Ease of*

Interpretation and *User Experience* (Appendix D). Some of these issues addressed the difficulty in retrieving PIREPs in a specific location or surrounding a specific airport. This may have been associated with the limitations of the NLP model used during the study and are discussed elsewhere in this document.

PIREP Retrieval via the Web / Mobile App Feasibility, Utility, and Usability

Participants were able to retrieve PIREPs via the website or mobile app in different modes including audio recording, voice-to-text transcription, and plain text formats. Ratings for feasibility, usability, and utility varied across these three formats. Overall participants gave the audio playback the highest ratings (Figure 9), followed by voice-to-text transcription (Figure 10), and plain text with the lowest ratings (Figure 11).

Pilots very much appreciated the ability to hear the voice of their fellow pilots from the audio playback easily on their smart phone via the mobile app. Nonetheless, they also noted the ability to read the voice-to-text transcription and plain text options at a glance (see Appendix E). A number of caveats about the reliability of the voice-to-text transcriptions and the plain text options were noted as well (see Appendix F and Appendix G). Because the NLP transcription was sub-optimal, pilots reported that they would not use these retrieval options as reliable sources of weather information and would instead rely mainly on the audio option.

Technical Challenges and Mitigations

Noise

Noise can have a negative impact on VTT accuracy. Since the primary goal of the study involved assessing the feasibility, utility and usability of PIREP entry and retrieval via VHF radio, the approach to minimize noise had to be cost-effective. Low-cost noise reduction measures included (a) optimizing the AGS antenna's location; (b) restricting range and altitude of the participating aircraft; and (c) implementing an audio-signal capture methods that ensured minimum alteration of the source audio. For the study's Oklahoma City area, the ground-based transceiver, its antenna, and the AGS were located at the Mike Maroney Aeronautical Center. Participating pilots were informed that the useful range of the AGS transceiver was approximately ten nautical miles (radius) for every one thousand foot of altitude AGL. For example, at 4,000 ft AGL an aircraft could expect the AGS to be usable at a range of up to 40 nautical miles from the Mike Monroney Aeronautical Center. Constraining participating aircraft to these altitudes and ranges ensured reasonably clear communication for most aircraft. (Notably, nearly all airline traffic operating at the flight levels communicated clearly with the AGS, even at longer ranges).

Further, to ensure minimum introduction of noise or distortion within the AGS, the hardware was specifically designed to be "spectrally flat". That is, the capture hardware did not alter the source audio as received by the transceiver. Although these measures were somewhat effective in minimizing noise, it was clear from the study's results that noise played a role in the accuracy of the transcribed text received from the VTT model.

In the context of the study and its 6-month data collection period, noise was introduced to the captured audio (voice) from several sources: (a) the cockpit, (b) the radio-frequency channel, (c) the transceivers, and (d) the pilot's microphone. Sources of cockpit noise included the aircraft's engine, the propeller, and airflow over the airframe. Engine and propeller noise each have spectral energy in the same audio band as human voice. Likewise, noise induced in the radio frequency channel from distant or very weak transmitters, lightning, radio-station harmonics, etc. also contribute spectrally to the human voice audio band. For these reasons, cockpit noise and RF-channel noise were viewed as major contributors to VTT transcription word-error-rates (WER).

Additional contributors to noise are related to radio- and audio-equipment. Each aircraft is equipped with a unique combination of transceiver and antenna. Aircraft transceivers can be one of hundreds of different makes and models. Also, antenna gain varies between antenna types, makes and models. Further, antenna placement on the aircraft as well as the aircraft's construction materials effect transceiver-antenna match (transmission efficiency). This variability, as well as the health of the aircraft's electrical system (grounding, alternator filtering, magneto or ignition integrity) etc. all contribute to unpredictable levels of noise.

Adding to the variability is the fact that most pilots use a personal headset and microphone. The microphone-in-use could be new, old, damaged, or even suffering from corroded contacts. In all cases, the variability in aircraft radio and audio equipment indicates varying levels of noise being introduced by these elements. Studies have shown that for poor signal-to-noise ratios, deep-neural-network (DNN)-based VTT WER could be 50% or more, whereas clean audio could have a WER of 5% or less. In short, noise in received VHF voice communications could have a significant negative effect on VTT transcription accuracy (Yin et al., 2015).

Pilot Language

Pilot language also impacts WER. A natural language processor (NLP) was used in the VTT tool for this study. Although pilots speak in English, the phrases and terminology typically used in aviation do not match English natural language. For example, a natural language speaker might say "I am nine miles south of Oklahoma City", whereas a pilot might say "I am niner miles south of Oskah Keelo Charlie at fower tousand". An NLP, not trained to expect "pilot-speak", would very likely produce and erroneous transcription of the audio.

To combat both noise- and language-induced errors, context-based "entity-matching" was implemented in the AGS. To aid the pilot in entering a PIREP, the AGS voice-user interface was specifically written with prompts – each prompt having an expected response and/or content. Not only did this approach make entering a PIREP easier for the pilot, but it also supported entity-matching error reduction for VTT transcriptions. For example, during PIREP entry, the AGS prompted the pilot to say their location for the PIREP. The expected response was a distance (in miles) from a nearby airport.

For the Oklahoma City study area, a pilot would have spoken a location of "10 miles

northeast of Chickasha." The NLP VTT tool could have returned an erroneous transcription of "ten miles northeast for chicken today." Context-based entity matching allowed rule-based substitutions, such as "chicken today" equals "Chickasha." In this case, a quick substitution could be made thus increasing the accuracy of the transcribed text. Entity-matching was used extensively, with changes made throughout the study, to improve the overall transcription accuracy.

Cloud Environment Challenges

Interface with the AGS

The CbTOPS platform includes a Representational State Transfer API for exchanging data with third-party systems. This API provided the interface between the AGS and CbTOPS for the PIREP Study. When the AGS received and transcribed a new PIREP, it would then submit the transcription and an audio file of the PIREP to the CbTOPS API, so that it could be displayed on the CbTOPS website and mobile app and archived for future analyses.

Receiving data from the AGS presented several challenges. The first was the submission of audio files. The audio file for each PIREP averaged about one megabyte, though some were over three megabytes. Though these sizes are well within normal files sizes exchanged over the internet, the AGS was experiencing latency of up to two minutes when submitting files to the CbTOPS' API. This delay was causing pilots to occupy the AGS radio frequency much longer than needed, as they awaited notification that their PIREP was successfully submitted.

Another challenge was parsing PIREP data from the audio transcription. The CbTOPS API would analyze the transcription of each submitted PIREP and attempt to extract relevant PIREP data such as: location, altitude, turbulence, icing, visibility, temperature, wind, and other weather observations. The variable nature of PIREPs made this very challenging. When prompted by the AGS to "state observed weather" the pilot could have responded with any number of observed weather phenomena, and in any order. They could also include additional information that did not fit into the Aviation Digital Data Service (ADDS) PIREP model we used (https://aviationweather.gov/dataserver/fields?datatype=airep).

In addition, the challenges in producing accurate transcriptions made the data parsing even more difficult because the parser used during the study was declarative. That is, in the code, every possible keyword and phrase that the parser had to recognize, had to be "declared." Therefore, inaccuracies in the transcriptions had downstream effects on the accuracy of plain text data parsing.

Numeric values were the most prevalently mis-transcribed words, due to their use in almost all plain-text data values. Homophones such as "one" and "won"; "two", "to", and "too"; "four", "for" and "fore"; "eight" and "ate" were the most problematic. Issues with certain data types existed, as well. For instance, when trying to extract relevant icing information, the CbTOPS parser looked for keywords including "rime." However, "rime ice" was frequently transcribed as "rhyme ice". In addition, many times airport names proved to be a challenge. CbTOPS used the direction and distance from airports to calculate the location of a PIREP. For

instance, if a pilot said "15 [nautical] miles north of Oklahoma City," the API would calculate a latitude of 35.642°N and a longitude of 97.573°W.

In cases where the location was mis-transcribed during the submission process, the API was unable to determine a location for the PIREP. This also presented a problem when pilots would try to retrieve PIREPs from a certain location for playback. Consequently, where the API was unable to determine a location, the default airport locations were used - either KOKC or PANN. As a result, a long list of PIREPs would be compiled for these two locations making it difficult to access (e.g., scrolling through multiple pages with PIREPs) via the web and app interface. As previously noted, entity-matching was used to improve the NLP transcriptions, and correspondingly, plain text data parsing improved over the course of the study, as well.

Participant Sign-Up

At the beginning of the study, the sign-up process included two different sets of steps. Information for the research portion of the study was run through CbTOPS while participants' compensation information was handled by a payroll contract support company. This meant that during the sign-up process, the payroll contract support company required different information such as a payment method preference (e.g., direct deposit) not required by CbTOPS. At that time, the payroll contract support company mandated that the sign-up process begin with a form they had previously created and used to track participant payments. Once complete, the participant would receive an email including their individual call sign and a link to continue the sign-up process on the CbTOPS website. This workflow was problematic because some pilots would immediately start submitting PIREPs with their call sign, before completing all the steps required for the research portion of the study (e.g., sign an informed consent form, fill out a demographics questionnaire).

Several revisions to the sign-up process were made to simplify the process. Eventually, it was determined that the simplest way to handle sign-ups was to have the whole process take place on CbTOPS. The pilots would input the required payroll information on CbTOPS, and it would then be submitted automatically (via an API) to the payroll contract support company system. The participant could then move on to the next step. In addition, the participants' call sign would not be assigned until the end of the process. While this new flow worked much better, it still involved multiple steps. This resulted in approximately 25% of potential participants not completing the sign-up.

Study Support for Participants

Support for study participants was provided primarily via email using the support@cbtopsatcami.net email address. Requests for support mostly fell into the following categories:

- Availability of biweekly surveys (see section below),
- Forgotten call-signs, and
- Payment questions (which were referred to the payroll contract support company).

In general, the support required by most participants was minimal. Approximately 40 requests were received over the six months of the study. The technical team spent one hour each week responding to email inquiries. In almost all cases, the inquiries were resolved with a single email response. In some cases, the issue was elevated to the Principal Investigator, who responded directly to the participant.

Participant Biweekly Surveys

The feasibility, utility and usability survey was posted on participants' CbTOPS account every two weeks (provided they had filed PIREPs during that period). An automatic email notification containing a link to each new survey hosted on CbTOPS was sent out, as well. When a survey form was submitted by a participant, the responses were recorded in the CbTOPS database, and the responses were sent to the Principal Investigator in an Excel file. An email was also sent to the payroll contract support company for payment processing. The main issue with the surveys was that participants often misunderstood the timing of a new survey. There are several aspects of this issue that warrant an explanation. First, the two-week survey periods were based on each participant's sign-up date, therefore making the survey dates different for each participant. Second, surveys were only available for participants who actually submitted PIREPs during a given two-week period. Third, only one survey link was displayed at a time. That is, the participant had to fill out their oldest outstanding survey before a link to the next one would be available. More support requests were received by the support team about this than any other issue. In almost all cases, an explanation of the survey criteria resolved the issue. Changes to the account page interface were made to address the problem:

- Included the closing date of the two-week period on the account page, in the link to the survey;
- Added a note instructing participants that if they have not submitted any PIREPs since their last survey, no new surveys will be posted.

Integration with Third-Party Software Providers

The main third-party software providers that were utilized during the study were AWS and Wufoo. Wufoo hosted the payroll contract support company sign up form. AWS was used for hosting the CbTOPS website, API and database, as well as for support email and file storage. Working with the Wufoo form proved to be a challenge. As previously discussed, the original requirement that participants sign-up using the payroll contract support company's Wufoo form created two problems:

1. At the beginning of the study, potential participants had to fill out forms on two different websites to participate in the study. This resulted in a larger number of people not completing the process.
2. By the time the sign-up process was moved to CbTOPS, the payroll contract support company sign-up link had already been widely shared and Wufoo did not allow an

elegant redirect from their form to CbTOPS. To do an automatic redirect, the Wufoo
form needed to be disabled. But since the payroll contract support company was still
using the data from that form, to track participants on the payment side, it could not be
disabled. Instead, participants had to click "Sign Up" on an empty form to continue the
sign-up process on CbTOPS.

Compounding these problems was the lack of technical expertise to use the advanced features of
Wufoo on part of the payroll contract support company. The CbTOPS technical support team
worked with the payroll team to enable the redirect, hide the form, and allow data to be
submitted from CbTOPS to Wufoo via their respective APIs.

Conclusion

This POC study successfully demonstrated the application of already existing as well as
state-of-the-art off-the-shelf technologies as one potential way to modernize the current PIREP
system. More specifically, while using the voice communication system found in most aircraft
today - a VHF radio - it explored a system that captured, queried and transcribed weather
information submitted by pilots in-flight automatically without talking to an air traffic controller
or a flight service specialist. Data were collected within two geographic areas, one in Oklahoma
and one in Alaska, where discrete VHF radio frequencies were assigned for the length of the
study. Close to 5,500 PIREP submissions and retrievals were collected over the course of the
study through voice recognition technology, stored, and processed using cloud computing. In-
flight, the PIREPs were disseminated via VHF radio, and on the ground via the web and mobile
apps.

Although operational issues related to the nature of a low-power radio ground station,
challenges with translating aviation specific language with off-the-shelf processing tools, etc.
were encountered; feedback from the participants was used during the course of the study to
make iterative improvements in multiple areas. By the end of the project, ratings of the concept's
feasibility, utility, and usability; as well as the extensive written feedback (Appendices C - D),
indicated overall high levels of satisfaction while at the same time highlighting areas that needed
improvement. In summary, this research showed that the approach chosen is feasible and affords
very good utility and usability.

The NTSB special investigation report (NTSB, 2017), and the pilots and controllers'
feedback collected during the focus groups conducted by FAA CAMI (Kratchounova, 2020),
proved invaluable for identifying the most error-prone elements of the PIREP system as it exists
today. The results from this POC study suggest that significant benefits could be derived from
conducting additional research to identify and assess the impact of further automating those
error-prone elements.

For example, a future study could investigate utilizing ADS-B data to autofill information
such as position, altitude, type of aircraft, etc., and allow the pilot to (a) focus on reporting
weather observations and (b) do it in a more efficient and effective manner. Furthermore, an

investigation into the contribution of this or similar concepts to optimizing pilots and air traffic controllers' workload profile could provide an insight to the broader positive effect of minimizing, or eliminating, the potential of human error in the PIREP submission and dissemination process.

In the context of an integrated system architecture and while preserving the human element (i.e., the direct observation of weather conditions made by a pilot in-flight), a potentially viable automation approach could be to utilize generative AI to transcribe the audio and parse the voice-to-text transcription into plain text. This approach could lead to an optimized human-system integration. If funded, empirical data from the next phase of this research would determine if, as compared to the currently existing system, this concept (a) increases the number and quality of PIREPs, (b) optimizes pilot and controller workload, (c) improves the PIREP system resiliency, and (d) positively impacts aviation safety.

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Appendix A

Demographic Questionnaire

Participant Call Sign_____   Date: _____

1) Pilot participating as:

❏ Student Pilot   ❏ GA Pilot   ❏ Part 135 pilot

❏ Part 121 Pilot   ❏ Other (Please specify below)

2) Do you routinely fly one or more airplane(s)?

    a) Please specify make(s), model(s) and tail number(s) (e.g., Cessna 172 N123BJ)

      i) Airplane #1 make, model and tail number: _____

      ii) Airplane #2 make, model and tail number: _____

      iii) Airplane #3 make, model and tail number:_____

      iv) _____

3) Please estimate your flight hours under the following

      conditions: Total flight hours:

      Flight hours in the past month: _____

Appendix B

IMPORTANT: The short survey blocks below are divided into the following groups:
1. **PIREP Submission**
2. **PIREP Retrieval**
   a. **Via VHF radio (audio playback)**
   b. **Via website and mobile app (audio playback)**
   c. **Via website and mobile app (voice-to-text transcription)**
   d. **Via website and mobile app (plain text)**

PIREP
SUBMISSION

(Every two weeks for the duration of the research)

On a scale 1 to 5 where **1=Very poor; 2=Poor; 3=Adequate; 4=Very good and 5=Excellent**, please evaluate the *Usefulness, Ease of use, Ease of interpretation and the overall Operational Viability/Practicability* of the concept based on your user experience in SUBMITTING PIREPs so far for this project.

Feedback Guide

When filling out this questionnaire, please express your personal opinion by considering the following:

- In the context of the type of operations you are involved, how doable/practical is the concept?
- Would the concept be beneficial for implementation in the national airspace (NAS)?
- Based on your experience so far participating in this research, how easy to use is the concept?
- Is it easy to interpret the user-system voice interactions?

PIREP Submission _via VHF Radio Call_	
Usefulness	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐
Ease of Use	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐
Ease of Interpretation (system-user voice interactions)	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐
User Experience	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐
Overall Operational Viability / Practicability	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐

1 = Very poor	2 = Poor	3 = Adequate	4 = Very good	5 = Excellent

PIREP RETRIEVAL

(Every two weeks for the duration of the research)

On a scale 1 to 5 where **1=Very poor; 2=Poor; 3=Adequate; 4=Very good and 5=Excellent**, please evaluate the *Usefulness, Ease of use, Ease of interpretation and the overall Operational Viability/Practicability* of the concept based on your user experience in RETRIEVING PIREPs so far for this project.

Feedback Guide

When filling out this questionnaire, please express your personal opinion by considering the following:

- In the context of the type of operations you are involved, how doable/practical is the concept?
- Would the concept be beneficial for implementation in the national airspace (NAS)?
- Based on your experience so far participating in this research, how easy to use is the concept?
- Is it easy to interpret the user-system voice interactions?

PIREP Retrieval via VHF Radio Call *Audio Playback*	
Usefulness	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
Ease of Use	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
Ease of Interpretation (system-user voice interactions)	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
User Experience	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
Overall Operational Viability / Practicability	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐

1 = Very poor	2 = Poor	3 = Adequate	4 = Very good	5 = Excellent

Additional Feedback

PIREP Retrieval Via the Website and Mobile App *Audio Playback*						
	1	**2**	**3**	**4**	**5**	
Usefulness	☐	☐	☐	☐	☐	
Ease of Use	☐	☐	☐	☐	☐	
Ease of Interpretation (system-user voice interactions)	☐	☐	☐	☐	☐	
User Experience	☐	☐	☐	☐	☐	
Overall Operational Viability / Practicability	☐	☐	☐	☐	☐	

1 = Very poor	2 = Poor	3 = Adequate	4 = Very good	5 = Excellent

Additional Feedback

PIREP Retrieval Via the Website and Mobile App *Voice-to-text Transcription*	
Usefulness	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
Ease of Use	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
Ease of Interpretation (system-user voice interactions)	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
User Experience	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐
Overall Operational Viability / Practicability	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐

1 = Very poor	2 = Poor	3 = Adequate	4 = Very good	5 = Excellent

Additional Feedback

PIREP Retrieval Via the Website and Mobile App Plain Text		
Usefulness	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐	
Ease of Use	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐	
Ease of Interpretation (system-user voice interactions)	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐	
User Experience	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐	
Overall Operational Viability / Practicability	**1 2 3 4 5** ☐ ☐ ☐ ☐ ☐	

1 = Very poor	2 = Poor	3 = Adequate	4 = Very good	5 = Excellent

Additional Feedback

Appendix C

Pilot Participants' Comments: Submission via VHF Radio

Date	Type of Operation	Comment
11/10/22	GA Pilot	Worked!
11/15/22	Part 121 Pilot	When I got to use it. It seemed to work with a few hiccups on repeating overall nice
11/17/22	GA Pilot	The system is improving.
11/17/22	Part 135 Pilot	I made an error in my location reporting (east vs. west) and when I told the system to change my report, it would only change the weather part, not the location information.
11/24/22	Part 135 Pilot	Was not able to establish contact with station past 28 NM North and Northeast of Nenana over 9 separate occasions twice out of the 9 station respond unable to connect wait 15 seconds and try again and the rest of the attempts got no response. Most of the attempts were made North of Fairbanks and as close as 10 miles north of PAFA at 6000 feet
11/29/22	GA Pilot	The interaction takes a long time and making corrections at the end is discouraging. I'd rather correct and re-record immediately after I botch my response. Separating the location from altitude was a good change because I would get so fixated on getting the distance from some feature that several times I would forget alt. I am concerned with how long the interaction takes. I was talking to ATC and switched to monitoring while doing the PIREP and I blocked some ATC calls. I resolved it by switching to split comms.
11/30/22	CFII	Have attempted to submit more than a dozen reports. The system only recognized me twice. We'll keep working on the matter.
12/1/22	GA Pilot	This is an early win the program. Thus far there are minimal reports, how the natural language can interpret the voice calls to provide pilots on the ground more clarity about local weather will be critical to expanding this nationally.
12/1/22	GA Pilot	If I mess up my location at the beginning of the PIREP I cannot go back and change it.
12/5/22	GA Pilot	The updated submission process is better now that the altitude is broken out into its own section. The system is also better at

Date	Type of Operation	Comment
		determining my call sign for submission purposes. It now recognizes the number two at the end of my call sign. I was unable to make 2 PIREP submissions because of the glitch. As stated the problem is resolved now.
12/13/22	GA Pilot	I have only tried to submit 2 so far. First one was great and worked just fine. The second one later in the day did not work quite as well. I wasn't receiving the voice very well via radio even though I was higher than I was earlier in the day. I got about halfway through and then just stopped receiving. This was likely just a radio transmission issue though and not an issue with the system itself.
12/13/22	GA Pilot	Very easy to use
12/13/22	GA Pilot	We need to get the submission time down.
12/14/22	CFII	It is working MUCH better than in the previous two-week period.
12/14/22	GA CFI	Signal strength is very weak, you have to be closer than 50 nm to Will Rogers. Takes too much time to file/ record the report, too much time away from talking to ATC to file a report.
12/15/22	Part 121 Pilot	Overall it was pretty easy. Took me two to get the hang of it.
12/15/22	GA Pilot	A little too much back and forth
12/15/22	GA Pilot	I am getting better at submissions; the system is also getting better.
12/17/22	GA Pilot	Overall, the System is operational he sounds with little to no errors. However, currently it moves a few seconds to slow for it to be viable in hard IMC conditions, as seconds spent with system are seconds not with ATC
12/19/22	GA Pilot	The submission process is great. It would be nice to be able to say "acknowledge" at the end of the transmission instead of waiting for the voice to finish its statement. The system is quick and I understand there is radio transmission limitations.
12/19/22	GA Pilot	was not able to make airborne PIREP
12/20/22	GA Pilot	Numerous times could not get past password in different locals trying to submit PIREP
12/24/22	GA Pilot	The answer to these two questions need qualifying:

Date	Type of Operation	Comment
		1) Would the concept, be beneficial for implementation in the national airspace (NAS)? Yes, but it depends how the actual final product pilot / system interactions would be. I don't believe I have enough information of live examples of how receiving the information while in flight will be useful, but I can see where being able to look the information up online before the flight or via ADSB while en route could be very useful. 2) Based on your experience so far participating in this research, how easy to use is the concept It is easy enough to use, but the delay in response is a bit slow. It takes roughly 4-5 minutes to file a report, and I would rather not be focused so much on the process while flying and navigating. The content is adequately simplified, but the delay in read back is a bit too long for my taste.
12/24/22	Part 135 Pilot	The numerous steps make it time consuming and difficult to monitor different frequencies at the same time. I'm curious if combining things like location and altitude into the body of the report would reduce time spent.
12/27/22	Part 121 Pilot	Still having a little trouble with time delay between transmission
12/28/22	CFII	So far it is working well!
12/29/22	Part 121 Pilot	Once I did a few, I got more comfortable with the system and what it expected. The system did interpret my callsign as SoonerState XXX a few times instead of SoonerState XXX. Once I started saying "SoonerState XXX", it seemed to do a better job of getting it correct.

Date	Type of Operation	Comment
1/1/23	Student Pilot	Easy to submit PIREPs through this system. Takes very little time to do so. The system always picks up on the user voice recordings.
1/3/23	GA Pilot	System still struggling with words like visibility, VFR, Nenana, negative, only about 180 degrees of reception mostly south. Sometimes it mistakes my call sign 762 for 761. No reception close to Nenana, large cone of silence.
1/5/23	Part 121 Pilot	VHF signal weak east of KOKC. Was just 40 miles away at FL330 but had difficulty hearing transmissions.
1/7/23	Part 135 Pilot	The numerous steps make it time consuming and difficult to monitor different frequencies at the same time. I'm Curious if combining things like location and altitude into the body of the report would reduce time spent.
1/7/23	Part 135 Pilot	When in Range, also near TRSA so changing frequencies can be a pain. Better range on tx and rx would be better.
1/8/23	GA Pilot	Only queried for location, altitude, and "adverse weather". I was never asked for aircraft type information during submittal. Using the standard format would be much better.
1/8/23	GA Pilot	I'm very excited about this system and I think it will be very useful. I think with this system more people will submit PIREPS. I am curious about how the system will work once it is out of experimental stage with regards to aircraft type. Would the person submitting also need to specify aircraft type since this information could be useful to those retrieving PIREPS.
1/10/23	Part 121 Pilot	Left PIREP on 12/30/22 worked great
1/10/23	GA Pilot	It's getting better!
1/12/23	Part 121 Pilot	I really like the system. At first I was skeptical of its ease of use, but after a few practices with it, I find that it is really easy to give and retrieve PIREPs. It's often difficult to get in touch with ATC on congested frequencies, especially when the weather is bad, so this would be a perfect way to be able to capture that weather data and provide it to pilots in a way that will not be a burden on busy air traffic controllers. Especially for VFR traffic, a pilot is more likely to

Date	Type of Operation	Comment
		call the automated system rather than try to contact a ARTCC center controller for PIREPs.
1/15/23	Student Pilot	The submittal system is very easy to use. There have been a few times where the system does not recognize what was said and asked for the request to be repeated. But a majority of the time it catches all that was said.
1/17/23	GA Pilot	PIREP submission improving over last few weeks. However, few times after the initial handshake with my call sign halfway thru the PIREP the computer voice it will address me as last frontier XXX instead of my own call sign of last frontier XXX.
1/17/23	GA Pilot	It seemed power of PIREP transmitter was very weak and hard to hear.
1/19/23	GA Pilot	Very useful but sometimes hard to get in contact with near SNL
1/21/23	Part 135 Pilot	I put a 3 for ease of use because I feel the numerous step process in submitting PIREPs is time consuming and cumbersome. I transit the area IFR often and so will submit while in cruise but also monitoring an ATC frequency. The multi-step process can be too much if the ATC frequency is congested. If I could potentially submit location, altitude, report, and remarks all in one transmission I think it would reduce the time spent.
1/22/23	GA Pilot	The system seems to easily identify voice inputs correctly when it is able to receive. When the system misses one input, it can be difficult to get the process started again.
1/22/23	GA Pilot	Grouping of numbers appears to be the only way to get the interpretation of voice to be accurate. For example, "fifteen south of Max Westheimer airport" works better than "one-five miles south of Mac Westheimer airport". This is non-standard phraseology is aviation communications. Pauses in voice transmission tends to degrade the overall system interpretation of submitted audio.
1/22/23	GA Pilot	The more I use the system, the more impressed I am. I think any initial issues for me can probably be attributed to too great a distance from the antenna for good reception. As long as I'm flying "in range" I can easily submit a PIREP in less than two minutes without any hiccups. The system hears me and understands me just fine. I think

Date	Type of Operation	Comment
		that's great to encourage the general flying public to submit more PIREPS.
1/24/23	GA Pilot	The radio range is very poor outside of 20 miles of OKC
1/24/23	GA Pilot	One of the main operational constraints I see is simply the range available with the radio at this time. I find it somewhat difficult to change frequencies on certain flights and get the PIREP in time. When I am able to, it's simple and fairly easy to use
1/26/23	Student Pilot	It is super easy to use!
1/26/23	GA Pilot	Some folks I'm hearing that are trying to submit reports are too far away and seem to get frustrated when the system doesn't respond.
1/26/23	Part 121 Pilot	Pretty easy just takes a few minutes which is stressful if monitoring multiple frequencies.
1/26/23	Part 121 Pilot	I think this concept is definitely practical for integration into the National Airspace System. It is a much-needed addition in my opinion. Air Route Traffic Control Center frequencies can get very congested, especially during periods of bad weather, and the controllers can get very task-saturated during these times. It would help to remove the workload from these center controllers and allow them to focus on aircraft routing and traffic deconfliction, rather than to write down PIREPs and enter them into a system. The user-voice interactions are getting easier to use for me as I learn what order the data is expected in. I think when the system rolls out, a short user guide that could be published that will walk the pilot through the prompts and what order to expect the system to ask for the data would be critical to getting buy-in and normalizing the use amongst the pilot population. Many pilots may at first be hesitant to use an automated system, but if they have a clear step by step quick reference guide and possibly a list of commonly used phrases that the computer is listening for, it would probably make the roll-out go more smoothly.
1/29/23	Part 135 Pilot	It drops mid submission, and you have to let it reset.

Date	Type of Operation	Comment
1/29/23	Student Pilot	Sometimes the system does not always catch what is said. But most of the time it will.
1/31/23	GA Pilot	Before finishing the PIREP the voice gives me an option to either say the report is correct or should I redo it! Great option, however, it restarts after altitude. Problem is it doesn't allow me to correct a known mistake in the location block!
1/31/23	Part 121 Pilot	Frequency picked up better at 40 miles out than 50. Worked well for first time using.
2/2/23	Part 121 Pilot	Radio reception weak at times-even when relatively close and at high altitude.
2/2/23	Military	40 miles away and 30000 feet. Really hard to hear
2/4/23	Part 121 Pilot	For my first PIREP in the system, it was pretty easy.
2/4/23	GA Pilot	Overall, this is a great tool. Opportunities for improvement - 1) the system should recognize more complex position reports than it does now. For ex: 15 miles on the 255 radial of the OKC VOR. 2) it seems that the system on wants "adverse" weather reports such that when something like "sky clear" is reported, it disregards that portion of the submission. System should be tweaked so accept all weather info, good or bad. 3) Transmission reception greater than 30 NM from OKC is challenging below 3500 ft. Understand this is a Beta test of the system, but a stronger transmitter or several repeaters should be considered. 4) A method for editing one section of your submitted report instead of having to redo the whole thing would be a huge plus.
2/5/23	GA Pilot	Sometimes reception makes it difficult to submit PIREPs, even at higher altitudes. Otherwise, it's very easy to use.
2/7/23	Part 121 Pilot	A couple of times it would disconnect and have to retry a second attempt but eventually it submitted
2/7/23	GA Pilot	Range of reception could be better
2/9/23	GA Pilot	The last step of confirming the PIREP is a little cumbersome now with the added narrative. System is getting better all the time.

Date	Type of Operation	Comment
2/9/23	Part 121 Pilot	This concept seems very practical and could be very beneficial to the national airspace system. It is very easy to use once you understand the order in which the computer expects you to say things. It is very easy to interpret what it is asking me as I go through the prompts.
2/10/23	GA Pilot	Station callback instructions could be shortened for call signs who have recently already submitted PIREPs
2/12/23	Part 135 Pilot	There is a dead zone to the north of the radio
2/12/23	Student Pilot	Sometimes the system will not understand what was said and ask for it to be repeated. But a majority of the time it catches what was said.
2/14/23	GA Pilot	After crossing over the 400 experimental PIREP submissions milestone I can say. I like we're we are at. The system still struggles with standard terms for example "ground fog" comes out like "ground Hog" funny but not useful. Crazy stuff like "Herbal Essence".
2/14/23	GA Pilot	The transmissions are a little weak, and do to that, aren't always clear.
2/15/23	GA Pilot	I attempted to submit a PIREP 50NM East of Oklahoma City which is supposed to be the limit of the tower's capabilities, however I cannot hear the AI until about 25NM away from the city.
2/18/23	GA Pilot	It is a very weak signal and hard to understand and needs to be corrected quite a few times
2/19/23	GA Pilot	I used the phonetic alphabet with pretty good success.
2/21/23	Part 121 Pilot	At times it's intermittent but after 2nd attempt it seems to work better last to reports I've submitted
2/21/23	Student Pilot	Could be less time consuming, but the experience is good
2/21/23	Student Pilot	Like it so far.
2/22/23	CFII	On, Thursday, February 16, at approximately 1715 local, I was flying with a student about eight miles north of KRCE at 4500 MSL when we encountered moderate to severe turbulence. That would have been a perfect situation for the PIREP system, but when I tried to file

Date	Type of Operation	Comment
		a PIREP, the system failed to recognize me. After three attempts, it stopped working altogether. My student, also taking part in this exceptional study, attempted to file using his call-sign, but the system was entirely unresponsive. Please, friends, do not hear a complaint in this statement, but rather a report that may be of use to you. You are doing something incredible valuable!
2/23/23	Student Pilot	The only comment I have is that we were told to say, "Oscar Kilo Charlie" instead of "OKC", but it seems like she understands OKC better than the former.
2/23/23	GA Pilot	System is very easy to file a PIREP with
2/23/23	GA Pilot	System understood turbulence when I said neg turbulence
2/23/23	GA Pilot	Steady improvements to the system!
2/23/23	Part 121 Pilot	On the initial radio call, the system sometimes has trouble identifying my call sign, Sooner State XXX. Sometimes it thinks I am saying Sooner State XXX. I have tried saying "Sooner State XXX" with some success. It is good that the system can understand more numbers than just 0-9. I think the operational system will be a huge benefit to the aviation community. This concept is very practical, as it will free up the ATC radio frequencies during periods of bad weather. Pilots will be able to submit and retrieve PIREPs on a discrete frequency, meaning that ATC can spend more time on traffic management tasks. This can really increase aviation safety in the long term.
2/23/23	Student Pilot	Responses from the system are a little slow, and the sound quality was not great. It was useable and understood all inputs.
2/24/23	GA Pilot	Overall, I'm impressed with the submission side of the PIREPs, and I know there's bugs to work out in ALL phases. I'll offer one thought for submissions; would it be a good idea to make the PIREP submission system similar to a "phone tree" where if you know what extension/department you want, you can press the number to expedite. In our case, possibly speak to the system prior to it completing its verbal prompt of what to do? I've tried to test and stress the system in a few different ways, please let me know if

Date	Type of Operation	Comment
		there's any specific verbiage curveballs, I can throw out to help assess the system.
2/25/23	GA Pilot	Very easy to interpret what the automated system said. The voice was very clear & stated what we as a pilot needed to state.
2/26/23	Student Pilot	I think this would be very beneficial to incorporate into the NAS. It provides a quick easy way to submit a PIREP.
2/26/23	GA Pilot	Overall, the system works well, however I've found the range to be useful only up to 25 miles away from KOKC
2/26/23	CFI	Reception can be a bit of an issue, further out towards the 50NM limit you have to climb pretty high to get reception and turn the plane towards the station to get reception. Other than that system works well
2/28/23	GA Pilot	Reception on my end cuts out before hearing entire dialog.
2/28/23	GA Pilot	Voice to proper text is still not perfect. Acronyms like IFR and VFR in remarks difficult at best. South of PAFA is a mountain Pass called Windy Pass. More than half the traffic headed south through that pass and it's imperative the IFR/VFR note is usable
2/28/23	Part 121 Pilot	As I use the service more, I am seeing it as a new and easy way to utilize PIREPs.
3/1/23	Student Pilot	It turns out that if you have a southern accent, it is especially hard for the PIREP system to pick up that you are trying to submit a PIREP.
3/1/23	GA Pilot	Submissions cannot be made more than 25NM away. The AI cannot be heard on frequency
3/1/23	Part 121 Pilot	Very user friendly. Easy to communicate with the computer voice. It would be beneficial for all users.
3/1/23	Part 135 Pilot	The process of submitting a PIREP with this system takes more time than calling FSS on the radio. Furthermore, there is more pressure in using the system because I have to remember the syntax and order of what the machine (AI) is looking for to process the information effectively. I know the AI is learning; however, it is nice to have a human understand a human and decipher with little effort. I messed up one of the calls because I forgot once the AI establishes communication you do not have to say your call sign anymore. This

Date	Type of Operation	Comment
		goes against what I'm use to with FSS, but no big deal at all, I mean pilots can and should be able to learn too.... Anyway, I tried to start over with the AI but only half of the submission allowed me to start over so in the report my call sign was embedded. I have found that I have had to reference the training material to refresh my mind a few times on the syntax of the system; but like I said, pilots should be able to learn new things too.
3/2/23	Part 121 Pilot	System is slow, but practical. I'd like to see a faster rate as the frequency is getting congested. Perhaps remove a step by allowing request or retrieve in first call "PIREP watch Alaska, last frontier XXX, submit/retrieve PIREP" and location and altitude in same segment "10NM southeast ENN, FL 200"
3/2/23	Part 121 Pilot	System still cuts out during submission attempts occasionally
3/3/23	Part 121 Pilot	In times of consistent moderate chop or deviating around weather, it could be distracting to have one pilot on a different radio issuing a PIREP when both pilots need to be on the same page with the deviations. And in adverse conditions that's when PIREPs become most important, but in this case the most nuisance to report.
3/3/23	Part 135 Pilot	Overall, voice recognition seems to pick up most interactions correctly. Sometimes it doesn't hear call sign correctly, but it could be my location. The voice to text translation seems to miss some phrases and misinterpret words. I know it is in the stages of learning and expect some anomalies.
3/3/23	GA Pilot	For ease of use, it is easy, but the system takes a long time. I know what I need to say and when, so it just takes a long time telling me what I need to do every time. Biggest example is on the end when you say affirmative. It runs through a super long message when I know I just need to say affirmative. Would be nice if I could just cut it off mid-sentence.
3/4/23	GA Pilot	One of the words it has trouble with is "Affirmative " probably my Okie accent but the only way to submit is use "Affirm"
3/4/23	Part 121 Pilot	I was within 50NM of KOKC and was unable to get the system to initiate. I tried 3 times to get the system to acknowledge me and no

Date	Type of Operation	Comment
		response. Not sure if the system was down or it just wasn't receiving me. When it works, it would be extremely useful and hope this works out. I can't tell you how many times I provide ATC a PIREP to never see it come out.
3/5/23	Part 135 Pilot	Voice to text transcription is not always accurate. Overall, the system is easy to use.
3/5/23	GA Pilot	If a reported condition is not properly understood by the system an entire PIREP submission must be submitted from the beginning. Perhaps using the standard PIREP criteria broken down into smaller sections would be easier. I fly multiple sizes and types of aircraft with no way to distinguish to the system which aircraft I am in at the time of PIREP submission.
3/5/23	Part 121 Pilot	I thought submission was pretty intuitive. Once withing range, it was clear and easy to use. I was at 32000 and definitely had to be within 100 NM to receive the ground-based transmissions. Perhaps a higher transmission wattage would be of use.
3/5/23	GA Pilot	PIREP submission is easy to use, but I think it does not properly put the aircraft in the correct location, which reduces its usefulness.
3/7/23	GA Pilot	We need the preamble to be brief. The reports take more time than they should. The location request should be explicit to say, "distance and direction from" so folks don't also include altitude.
3/8/23	CFII	It's working WELL (but WOW is the signal weak).
3/9/23	GA Pilot	Glad to see that something was done to curb the abuse of your generosity. The system seems to improve and get smarter all the time.
3/9/23	Part 121 Pilot	A user guide for submitting PIREPS would be beneficial for both the experimental system and the operational system. I listen to other pilots struggling to make their PIREPs due to not understanding at first how the system wants to hear their information and I can hear in their voices their frustration as they call back to try again after the system says "Try again after fifteen seconds." For example, no need to repeat their callsign on every response to the automated system, not speaking in easy-to-understand numbers and words, and avoiding

Date	Type of Operation	Comment
		colloquialisms such as "It's a bumpy ride at Three Four Oh". Instead, a guide that would direct the pilot to be clear and concise in saying "Continuous Light Turbulence for Cessna Citation", etc could provide more useful results for the research and for the operational product.
3/9/23	Part 135 Pilot	Especially as I become more proficient in the operation, I can see this being useful in cruise.
3/9/23	Student Pilot	I attempted several times over the course of a few days to make a PIREP. I was only 10NM from OKC and at 4500 when trying to make the calls and the lady would acknowledge my call sign and then say sorry cannot make PIREP. I tried several different times before finally giving up and trying the next day.
3/9/23	GA Pilot	When I tell the system negative turbulence it says "you reported turbulence"
3/9/23	Student Pilot	When she repeats remarks or weather, sometimes she says it wrong.
3/10/23	GA Pilot	Having submitted quite a few PIREPs at this point, the submission process is second nature. I can't come up with a tweak or adjustment to improve it.
3/10/23	Part 121 Pilot	In the 121 environment which I was operating in, this concept isn't as useful as it would be for GA Pilots. However, I think it could be EXTREMELY USEFUL as a means of soliciting PIREPs for those not on IFR flight plans.
3/12/23	Student Pilot	The system does not catch what is said if you start talking immediately after you hit your radio button. You need to pause for a second then speak.
3/13/23	Part 121 Pilot	The AI is getting better!
3/13/23	Student Pilot	Sometimes I lose contact with the radio frequency. There are also other times where it does not register what I say, and I need to repeat myself multiple times.
3/14/23	GA Pilot	Seems to work great except for linguistic some words just pop up for no apparent reason. I wish I had a word to stop the process at any

Date	Type of Operation	Comment
		time and restart it. The only way I can redo it 100% is to leave the mic closed and let it evaporate.
3/14/23	GA Pilot	It seems the transceiver is pretty weak so that I need to be fairly high and/or turn off the radio squelch to pick up the audio. More power!!
3/15/23	Part 121 Pilot	System works very well. Easy to use.
3/15/23	Part 135 Pilot	As mentioned in previous surveys it is difficult to fully test and see the practicability of this system when line of sight does not work within the range specified in the program. I do find it easier to talk a person than this AI.
3/16/23	Part 121 Pilot	System is still a little slow, I discovered you can request to submit and retrieve in your initial call making that part a little quicker. I've run into a problem where 30 NM east of ENN in the decent to Fairbanks around 13,000', and in the climb out of Fairbanks through 20,000' 50NM south of the station, I lose the station during the final read back and submission of my PIREP as if the station browns out during the transmission of the readback, squelch does not help but the station can be accesses immediately after it drops out, so I suspect it may be a transmission issue.
3/16/23	Part 135 Pilot	Sometimes when the system reads back the type of info I submitted it doesn't read back 2 or 3 or the categories. It's different every time
3/17/23	Part 135 Pilot	Completing PIREP submissions is easy and useful. As various weather conditions are encountered, it is fairly easy to submit PIREP for conditions observed. Upon viewing submissions on the website, the text translations of submitted information is getting better. There are still times when the text is not understandable, but the audio from the pilot submission is available to listen to and correct the misinterpretation. Having both for review keeps the data more accurate.
3/18/23	GA Pilot	I think it is a very good tool for pilots to use but it takes some adjustment to get it to work. Some of the adjustments are speaking slowly and understanding what words it understands and which ones it doesn't. Example (2500 doesn't seem to work but 2-5-0-0 works). At the end it doesn't seem to understand affirmative but understand

Date	Type of Operation	Comment
		affirm. I am waiting at least a second before speaking on all voice calls.
3/18/23	Part 121 Pilot	Stronger radios would be nice
3/18/23	GA Pilot	Ability to correct specific parts of submission instead of "start over" would increase ease of use and user experience.
3/21/23	GA Pilot	Need to make automated comments briefer
3/23/23	GA Pilot	System is getting better all the time!
3/23/23	Student Pilot	Range of transmission is kind of short.
3/25/23	Part 135 Pilot	Occasionally over the last two weeks submissions would cut out halfway through the process and the new submission would have to be started.
3/26/23	Part 135 Pilot	The system seems to be making a lot more mistakes than it used to. Getting the pilot ID wrong sometimes. It has also been dropping at random times and it's been doing it a lot.
3/26/23	Student Pilot	Sometimes you will have to repeat something to the system. But it usually picks it up after the second time.
3/28/23	GA Pilot	System couldn't recognize my report.
3/28/23	GA Pilot	Reception and locations of ground radio is paramount
3/29/23	Part 135 Pilot	On any north bearing out of ENN (~330 - ~060), the unit is not usable below 10,000' MSL. I know this is a test, and it was probably placed at the airport for ease of access. However, if this system is implemented in other locations or stays at ENN then line of sight with regard to terrain blockage needs to be considered. A lot of the interior Alaska pilots are on those radials with regard to ENN.
3/29/23	Part 121 Pilot	System works great
3/29/23	GA Pilot	I attempted to make 2 calls, approximately 20 NM South of the tower, the frequency was operating but the transmission was finicky and would cut in and out. The range of the tower is not very good,

Date	Type of Operation	Comment
		and although the range is 50 NM, I can usually only get back-and-forth transmission about 20-15 NM away.
3/29/23	GA Pilot	A stronger transmission signal would be a major benefit.
3/30/23	Part 135 Pilot	A week ago: System doesn't pick up call sign correctly or have trouble hearing transmission and in the read back doesn't list all the categories that was reported and for the last 3 days: system been offline
3/31/23	Part 135 Pilot	Activating the PIREP submission and retrieval has had mixed results. Voice recognition of callsign has been hit and miss. I have multiple occasions when I have to let the system time out and try again until it responds with my correct call sign. I take care to enunciate correctly, and it still misses sometimes.
3/31/23	Part 121 Pilot	Could be considered time consuming in a time when you would want quick reporting/retrieving.
3/31/23	GA Pilot	My ranking is lower than before because it seems like it isn't picking up as far anymore. I was at 5,500 feet over Sundance KHSD and struggling to pick up a signal basically every day this week. Before I could be at 4,500 and 15 miles northwest of Sundance no problem.
4/1/23	GA Pilot	Getting better understands my "Affirmative " which a noticed the last few tries.
4/1/23	GA Pilot	Would be helpful if more elements of submission were read back to you by the machine so you could verify they were understood appropriately then provide ability to change individual parts.
4/2/23	GA Pilot	Range of use appears to be much less than the designed 50 nautical miles.
4/4/23	GA Pilot	I have to turn off the Squelch to hear the transmission on the east side of Tinker.
4/6/23	GA Pilot	Excited to see where we go from here!
4/6/23	GA Pilot	Frequency would get clogged sometimes, system occasionally had trouble recognizing the difference between "submit" and "retrieve"
4/7/23	Part 121 Pilot	A few submissions required me to over-enunciate certain items (position/conditions). It's more practical to submit through ATC

Date	Type of Operation	Comment
4/8/23	Part 135 Pilot	Extremely useful for days with local adverse weather conditions.
4/11/23	GA Pilot	Communication cutting out during both receiving and transmitting. Took three submissions to get one successful one.
4/12/23	GA Pilot	Needs a stronger transmitter signal.
4/12/23	Part 121 Pilot	Can see as an excellent program for GA aircraft.
4/15/23	GA Pilot	Submit still works after 4/7 and I think pilots would use it during flights and it is somewhat easy to use. It gets easier the more you use it.
4/20/23	Student Pilot	Still seems to have trouble understanding even when at altitude
4/23/23	Part 135 Pilot	The radio return would cut out mid-sentence many times
4/29/23	GA Pilot	Seems to not be on all the time when I go flying

Appendix D

Pilot Participants' Comments: Retrieval via VHF Radio

Date	Type of Operation	Comment
11/10/22	GA Pilot	Only gave all PIREPs, not area specific
11/21/22	GA Pilot	The voice retrieval system worked but there were no PIREPs to play back.
11/29/22	GA Pilot	I have not yet retrieved a PIREP using PIREP watch in flight.
11/29/22	GA Pilot	This worked really well.
11/30/22	CFII	Though it has only worked twice, it seemed to work well.
12/1/22	GA Pilot	Once she starts playing PIREPs there is no way to stop her, but not sure there would be a way to stop mid-stream.
12/5/22	GA Pilot	Once this system is interfaced with other online weather products it will be one of the greatest additions to overall PIREP submission and pilot awareness. Right now due to lack of submission I have not be able to fully utilize the system and assess it.
12/13/22	GA Pilot	I have not yet retrieved PIREPs via radio call.
12/13/22	GA Pilot	I like this
12/14/22	GA CFI	Ok, if you do it from an iPad
12/15/22	GA Pilot	Minimal reports so far.
12/15/22	GA Pilot	I wish we could set the maximum number to be retrieved.
12/19/22	GA Pilot	I still have not been able to use this side of the system enough to give adequate feedback.
12/19/22	GA Pilot	Have not been able to make a report
12/20/22	GA Pilot	Terminology was goofy
12/24/22	GA Pilot	I would suggest that if this proves to be a fully developed project in the future, that it utilizes local times only for in-air read back or saying something like "6 hours and 20 minutes ago", to reduce the need for a pilot to do the ZULU time calculations while flying. Not every pilot is proficient with ZULU time, without time to process it.

Date	Type of Operation	Comment
12/27/22	Part 121 Pilot	Did not request
12/27/22	GA Pilot	I have not yet retrieved an automatic PIREP via radio.
12/29/22	Part 121 Pilot	On one occasion I tried to retrieve a PIREP and it would only give me the option to give a PIREP that time.
12/30/22	Part 141 CFI	Retrieving PIREPs via voice is a little clunky given the ubiquity of iPads and connectivity in my operation (121 with onboard Wi-Fi)
1/8/23	GA Pilot	I think the PIREP retrieval system will be very useful for cross-country pilots. There are a lot of times when I've been flying cross-country when I wished there was a system like this!
1/10/23	GA Pilot	Very easy to use, would like to be able to select general direction of PIREPs sometime i.e. PIREPs within 30NM to the S or SE of OKC
1/12/23	Part 121 Pilot	I like how the system plays back the recording of the pilot's PIREP. This way, the pilot retrieving the PIREP can hear in the "first person" what the reported weather was, versus an air traffic controller writing it down and explaining it "secondhand" or "third hand".
1/17/23	GA Pilot	PIREP retrieval is very difficult for me to get a PIREP in the general area needed. Once activated, it starts reading back a long list of random PIREPs not applicable and it's impossible to stop it. Have to shut down radio to get it to stop. Suggestion if we had a small pause between PIREPs retrieved for the pilot to jump in and give the call sign and trigger a stop the process?
1/21/23	Part 135 Pilot	I'm very excited about this capability! I've run into a couple instances where one user completely monopolized the frequency by attempting to retrieve reports repeatedly. Including to numerous locations not even covered by the experimental reporting system. So much so that I gave up even trying to utilize the system those days.
1/22/23	GA Pilot	System didn't appear to adequately take into account requested location to retrieve PIREPs.
1/22/23	GA Pilot	Retrieval always works great for me. No issues.

Date	Type of Operation	Comment
1/24/23	GA Pilot	The voice often time cuts out over the radio and I occasionally miss the read backs when the AI asks what I am needing/wanting. Once I am able to get a solid signal throughout, it seems to work well
1/26/23	GA Pilot	System has problems getting locations correct which translates into no PIREPs to retrieve in some areas or PIREPs from other areas being played that are not in the area requested. I think the system is getting better but still has room for improvement.
1/26/23	Part 121 Pilot	The PIREP retrieval is just as important as the PIREP submission in my opinion. Many aircraft do not have data link capabilities (or if they do, in some areas of the NAS they may not get good reception) and the automated PIREP retrieval system will allow those pilots to be able to get access to weather reports to factor into their aeronautical decision making. I could see this being especially useful in remote areas, especially Alaska where datalink or cell phone coverage is lacking. I think this is a very practical use of the system and I see this increasing aviation safety.
1/28/23	GA Pilot	Too long
1/30/23	GA Pilot	Had difficulty using command "retrieve" to listen to PIREPS
1/31/23	GA Pilot	Works better now we can use four letter identifier. No map to touch while flying
2/2/23	Part 121 Pilot	Will need to eventually develop some type of sorting or "filtering" capability to retrieve PIREPS most likely relevant to my type of operation.
2/4/23	GA Pilot	Again, conceptually, this is an excellent tool. Several comments: 1) the system seems to ignore the distance portion of the requested PIREP retrieval and simply spit out all PIREPs submitted in the area. For ex, a request for all PIREPs within 10NM of Shawnee produced several PIREPs submitted near the OU airport. 2) At the end of the replay of final PIREP, recommend stating end of transmission.
2/5/23	GA Pilot	I love the concept of PIREP in-air retrieval over a dedicated frequency. Could be very helpful.
2/7/23	GA Pilot	I enjoy the retrieval of PIREPS more because it's so quick and easy. Submitting is fairly easy, but can sometimes take longer. If I need a

Date	Type of Operation	Comment
		quick PIREP close to my destination airport/airport along the route of flight, it's very easy to ask and it's an efficient use of my time
2/8/23	GA Pilot	It gave me PIREPs outside my requested distance, but still useful
2/9/23	GA Pilot	I have to repeat distance and location most of the time. There is often a delay from when I request and when it starts playing the PIREPs. I'm sure that is a function of having to get the PIREPs over the internet but sometimes the delay is long enough that I'm not sure if the system is working or not.
2/9/23	Part 121 Pilot	The PIREP retrieval is just as important as the PIREP submissions in my opinion. This will enable pilots to get weather updates even when the ARTCC frequencies are crowded during periods of marginal weather. It very easy to use and it is a huge plus to be able to hear the audio file from the pilot submitting the PIREP firsthand.
2/10/23	GA Pilot	PIREPs retrieved seem to be given at random or for the entire area regardless of requested airport and radius. Additionally, PIREPs given by a user are read back to the same user when retrieving - this is redundant and clogs the frequency.
2/11/23	GA Pilot	Too long to listen to all the PIREPs if there are multiple. Should allow for a cancellation feature
2/12/23	Student Pilot	I think this would be very beneficial to incorporate into the NAS. It provides a quick easy way to retrieve PIREPs.
2/12/23	Part 135 Pilot	When requesting PIREP for specific locations, it doesn't separate where the PIREPs are from very well
2/13/23	GA Pilot	The mileage filter does not work. It read the same PIREPs whether I asked for those within 1 or 5 miles at different airports
2/14/23	GA Pilot	Excellent system! The only caveat I experience is at the beginning it seems that the system is struggling with the work "retrieve." Almost, every time I tell the system I want to submit a PIREP it proceeds on the first call. Not so on the retrieval option. It general takes two or three times or have to recall. It's only the retrieval portion. When I say "within 30 miles of PAFA" it gets it first time.
2/14/23	GA Pilot	Again, transmissions are a little weak, and fade out.

Date	Type of Operation	Comment
2/15/23	GA Pilot	It asks me twice how far I am from the station, I am not sure if it does not hear me the first time and understands me the second.
2/18/23	GA Pilot	It seems like it groups everything around the OKC airport but maybe just because everyone reverts to OKC when it doesn't understand other airports.
2/18/23	GA Pilot	Would love if it were only one at a time instead of three. Or at least the option to hear multiple.
2/19/23	GA Pilot	The retrieval seemed to recognize the phonetic alphabet better than saying the actual name of the airport.
2/23/23	GA Pilot	System is very easy to access
2/23/23	GA Pilot	The system sometimes stumbles on locations and distances.
2/23/23	Part 121 Pilot	I think this concept is very practical. As an airline pilot, it is often difficult to get a word in with the ATC controller on a busy frequency during times of weather. Being able to dial up the PIREP frequency and retrieve a PIREP for weather ahead will be very helpful and will increase aviation safety. If the WIFI is working on my airplane, I can pull the PIREP up on the app or CbTOPs website, but if the WIFI is not working on my airplane (which happens often), then I can dial up the PIREP frequency and listen to the recent PIREPs.
2/24/23	GA Pilot	I'm sure the bugs are getting worked out, but when retrieving a PIREP within a requested specific mileage/airport, the system seems to play whatever the most recent experimental PIREPs are instead of those falling within the requested criteria.
2/26/23	Part 135 Pilot	There is no distinction of location. When I request a PIREP for ANY location, it just reads back the 3 latest PIREPs as long as they were in the last 3 hours. Location doesn't seem to matter.
2/28/23	GA Pilot	Reception cuts out before entire PIREP is received.
2/28/23	GA Pilot	Suggest a ratio of one retrieval out of ten PIREP during experimental test
3/1/23	Part 135 Pilot	I have found the retrievals to be given back to me in areas that I did not define, which is frustrating because I'm not sure if the AI has

Date	Type of Operation	Comment
		thought I said something else or it does not know where locations that the pilot submissions given are.
3/1/23	Part 121 Pilot	I like that you can use a specific range when requesting preps.
3/1/23	Student Pilot	There were times when the system was down, and the reception stops at around 35-40nm at 4500MSL.
3/2/23	Part 121 Pilot	Still slow
3/3/23	Part 135 Pilot	I have been filing and retrieving systematically to determine if the system correctly locates PIREP and can retrieve according to location. It seems that is just gives the last 3 PIREPs that were filed no matter the location.
3/3/23	GA Pilot	I am giving this a 3 on ease of interpretation. I have noticed that I haven't had a single problem when giving my location to submit a PIREP, but every single time when I want to receive one, it makes me say it at minimum two times. But when I submit it is always the first try.
3/4/23	GA Pilot	I think it is an easy concept and I can see it being used a lot in marginal weather to see what is actually out there before reaching the reporting area.
3/4/23	Part 121 Pilot	This is another area I was unable to get activated. I tried twice and both times, on that call, the system didn't respond. Men's voice versus female voice?
3/4/23	GA Pilot	System needs to allow more specific retrieval location - perhaps numbering reports or having letter designation for specific reports. Having to hear them all is time consuming and onerous while trying to fly a plane and monitor other frequencies
3/5/23	GA Pilot	It appears the "distance within" portion of requesting PIREPs is not operational. Will verify this on next submission/retrieval period.
3/5/23	Part 135 Pilot	I am not sure about the overall usefulness of the program for retrieving a specific type of weather. For example if a pilot wanted information about only icing they would have to listen to a lot of information vs simply asking a weather briefer on a flight service station.

Date	Type of Operation	Comment
3/5/23	Part 121 Pilot	Voice commands from station were clear and easy to use. It takes patience and clear concise speaking within a timely manner to interact. It would be a fantastic tool.
3/5/23	GA Pilot	In order to test the retrieval system, a few weeks ago, I attempted submitting 4 separate submissions within 5 NM of one airport using the identifier for the airport. I then tried retrieving PIREPS around 5 NM of that airport. The system would sometimes give me one of my submissions around the airport but most of the times it would give me submissions that were much older from areas on the opposite side of the city. This seems to indicate the submission is not picking up on the correct locations. I've also noticed that the retrieval system seems to offer up PIREPS at random. It does not give the pilot the closest PIREPS to the location the pilot asked for, nor does it give the pilot the most recent PIREPS either. I think it would be more helpful if it either gave the 3 latest PIREPS or the one or two PIREPS in the area the pilot requested. As it is, it's not very practical considering the retrievals are either old or not in the requested area.
3/7/23	GA Pilot	This worked for me fine, but there was someone before me who could not get it to work. He sounded like he was saying the right words. I asked for reports east of KTIK but I heard it say something like reports for ROE? It did not provide my report that I had just given. Something went wrong.
3/9/23	GA Pilot	The location function still has room to improve. Seems to default to Nenana a lot.
3/9/23	Part 121 Pilot	I have tested the system to see what results I would get on retrievals by trying different airport identifiers, and it seems to be a bit random in that I will request PIREPs within ten miles of RQO, yet I will receive playbacks of PIREPS near Shawnee. Or, I will request within five miles of CHK, and I will get playbacks from within five miles of OKC or TIK. Meanwhile, I know that there have been recent PIREPs within the ranges that I requested but did not receive because I can pull them up visually on the CBTOPs web site. Possibly the system just gets confused and defaults to the most recent reports, or maybe it does not recognize "Romeo Quebec Oscar" when retrieving a PIREP. This will

Date	Type of Operation	Comment
		be an important part of the retrieval system to get ironed out before it goes operational.
3/9/23	Part 135 Pilot	I think the retrieval via the automated system would prove more challenging. I tried to retrieve any PIREPs within 50 miles of OKC, and it said that none were available. Assuming the algorithm can correctly interpret the location of the PIREP with the radio call inbound, I still don't know if I would want to listen to an unorganized list of PIREPS X DME around a certain point.
3/9/23	Student Pilot	Similar to the submission process I asked to retrieve submissions but the lady had trouble hearing or understanding what I as saying despite being close enough.
3/9/23	GA Pilot	Sometimes locations are off (e.g. request within 10NM of OUN and gives PIREPs at RCE)
3/10/23	GA Pilot	I lowered the scores for usefulness and overall operational viability/practicability from the last survey because the system still cannot pull PIREPs within the requested airport/distance. Previously it seemed the system would play the three most recently submitted PIREPs in Oklahoma no matter what airport/distance you requested. Now, it's not pulling the most recent three but appears to be random PIREPs within the last hour.
3/10/23	Part 121 Pilot	PIREP retrieval is very helpful for any pilot operating in all environments. The voice recognition software had a little bit of difficulty recognizing the station I was asking about, but that could have happened for a variety of reasons.
3/11/23	GA Pilot	One of the flaws with the system is it will read PIREPs completely unrelated to the area for example will read Nenana PIREPs for Fairbanks
3/12/23	Student Pilot	The system does not catch what is said if you start talking immediately after you hit your radio button. You need to pause for a second then speak.
3/12/23	Part 135 Pilot	It doesn't separate retrievals. So if you ask for within 5 miles of an airport, you simply get back the last three, regardless of location. It did work correctly once a few days ago.

Date	Type of Operation	Comment
3/13/23	GA Pilot	Doesn't filter to the range given from the airport
3/14/23	GA Pilot	Sure we could select like three out of five available PIREPs
3/15/23	Part 121 Pilot	Easy to use. I like you can request a distance to request preps from, ie 10 mile range
3/15/23	Part 135 Pilot	This is the feature that I like better because it reads other pilots PIREPs which could be useful in difficult situations. But see comment above.
3/16/23	Part 121 Pilot	Two Ideas: Flying south of the station currently there are few PIREPs submitted, often retrieval is my own submission. An online option to elect to omit retrieval of PIREPs from myself would be nice. Location wise a retrieval request with a default radius of 20-50 miles would be nice to reduce retrieval of PIREPs that aren't really useful. For example, I rarely fly north of Fairbanks and I'd like to know the PIREPs over the north edge of the Alaska range for turbulence. Requesting PIREPs 50 miles south or southeast of ENN (with a default search radius of 50NM) would be much more useful than an all-encompassing search of within 60 miles of ENN which would include all the PIREPs for the Fairbanks area, leading to a long retrieval process for the information I'd be looking for.
3/16/23	GA Pilot	Something that stood out to me the other day when I was retrieving PIREPS was that it doesn't say anything at the end. It just finishes the last one and that's it. Feels unfinished like it stopped working. It should have a similar message as when you finish submitting a PIREP.
3/16/23	Part 121 Pilot	The location filter when retrieving PIREPs does not work well. I often get PIREPs that don't match the location that I requested.
3/17/23	Part 135 Pilot	Retrieving the PIREPs has been fairly easy. Sometimes the voice recognition of call sign is not accurate and have to wait for the system to reset and try again. It seems the system is learning more as we go. Location identification and giving proper PIREPs for that airport seem to be getting better.
3/17/23	GA Pilot	Retrieval hasn't worked as well as submission. It often doesn't get my call sign and I have to repeat, same with location. But I've never had that happen even once with submission.

Date	Type of Operation	Comment
3/18/23	GA Pilot	The one I have trouble with is retrieve for retrieving PIREP. It very rarely gets it the first time or so and most of the time it times out before it works. I am waiting at least a second before speaking on all voice calls. It usually takes several times before it understands the locations before it responds. I think it would be very useful to be able to check the weather during a cross-country after it is fully operational.
3/19/23	Part 135 Pilot	It would be useful to be able to ask the system for a specific type of weather report. For example, "ice" or "visibility" in Fairbanks.
3/21/23	GA Pilot	I asked for PIREPS and the system successfully responded but it was unclear it provided the location I requested.
3/23/23	GA Pilot	Great to hear reports in pilot's own words and voice. System seems to still have some trouble with locations.
3/23/23	Student Pilot	Retrieving the PIREPs is easy, but the usefulness of what the pilots are reporting is hit or miss. Sometimes they just report outside air temp.
3/23/23	Part 121 Pilot	At some points despite me speaking very clearly the AI had a hard time picking up words. I was also at appropriate altitude and distance.
3/24/23	GA Pilot	Still needs a little cleanup as far as location and distance of narrowing down the requested PIREP retrieval
3/25/23	Part 135 Pilot	Just like with these submissions, every now and then over the last couple weeks retrievals would cut out halfway through the read back.
3/26/23	Part 135 Pilot	It still doesn't retrieve where you specify.
3/26/23	Student Pilot	The system has a hard time understanding "retrieve PIREP" when asked if you would like to submit or receive.
3/26/23	GA Pilot	Would be useful to have a prompt at end of retrieval
3/27/23	GA Pilot	It gives them all regardless of mileage or airport.
3/28/23	GA Pilot	Again location, location, location of antenna ground radio
3/29/23	Part 135 Pilot	Other than the line of sight issue, I like the ability to listen to other pilot PIREPs, it is a direct translation from the pilot which is nice.
3/29/23	GA Pilot	Had to call back several times before my voice commands were recognized by the system.

Date	Type of Operation	Comment
3/29/23	GA Pilot	It asks me twice for my location every time.
3/30/23	Part 121 Pilot	In addition to my last survey suggestion of direction-based retrieval, the retrieval could be faster.
3/31/23	GA Pilot	It grabs unnecessary reports from all over outside the requested area, for example requesting one within 10 miles of Healy give reports north of Fairbanks
3/31/23	Part 135 Pilot	Accuracy of retrieval seems to vary. Some days it gives you the particular area you are requesting, and other times it just spits out the most recent 3 PIREPs recorded. Again, it is a hit and miss if it locates the PIREPs per the requested area. The system seems to have quit working last Thursday, March 30 and no submissions or retrievals have been possible. I have been attempting several times per day.
4/1/23	GA Pilot	Needs a little work on understanding my "Retrieve." Sometimes I cannot get it to work saying retrieve so that I try saying submit and it takes that so that is why it may seem like I do 2 PIREPs back-to-back. When I do get it to retrieve, they are easy to understand.
4/1/23	GA Pilot	Needs to read back requested location and verify its correct with user.
4/1/23	GA Pilot	DO not need to hear all reports - need to be able to hear specific reports from specific areas
4/2/23	Part 135 Pilot	Would be more useful if specific weather info could be retrieved. For example, "ice within 10 miles of Nenana"
4/4/23	GA Pilot	The few times I tried this feature the report included PIREPS not in the area requested.
4/6/23	GA Pilot	I still think it is great to hear PIREPs in the submitter's own voice and words.
4/6/23	GA Pilot	Won't understand "Receive"
4/7/23	Part 121 Pilot	It would be nice to have stricter criteria for retrieval—"within xx NM of ABC at 10000"
4/11/23	GA Pilot	Communication cutting out during both receiving and transmitting. Took three submissions to get one successful one.
4/12/23	Part 121 Pilot	Not really useful, unless giving turbulence report for airline ops.

Date	Type of Operation	Comment
4/14/23	GA Pilot	Retrieval doesn't pick up location or the call sign as well as submission.
4/15/23	GA Pilot	I am sure you know this but it doesn't work after 4/7. i have tried serval times and could not get it to work, but before it worked good and was useful.
4/16/23	Part 135 Pilot	Would be more useful if the pilot retrieving the information could request conditions relating to a specific type of weather. I.e. "ice" or "thunderstorms."
4/20/23	Student Pilot	Easy to understand her voice once she understands you
4/23/23	Part 135 Pilot	It is not near as useful as ATC because it doesn't differentiate between my location vs PIREPs received.
4/29/23	GA Pilot	Look like I am the only one still submitting
2/13/26	Student Pilot	Sometimes the system will not understand what was said and ask for it to be repeated. But a majority of the time it catches what was said.

Appendix E

Pilot Participants' Comments: Retrieval via Website/App (Audio)

Date	Type of Operation	Comment
11/17/22	GA Pilot	Excited to see a more wide-spread implementation of this
11/29/22	GA Pilot	This is interesting
11/30/22	CFII	Have not attempted retrieval.
12/13/22	GA Pilot	Very nice to have
12/13/22	GA Pilot	Several of my reports show up on top of KOKC instead of where I reported from.
12/14/22	GA CFI	Signal strength is very weak, you have to be closer than 50NM to Will Rogers. Takes too much time to file/ record the report, too much time away from talking to ATC to file a report.
12/15/22	GA Pilot	I still have the occasional problems with my Mac and the Safari browser not playing well with the website. Reloading the page seems to fix most of the problems.
12/15/22	GA Pilot	PIREPs would not pop up in location
12/19/22	GA Pilot	This is my favorite way to retrieve PIREPs!
12/19/22	GA Pilot	Unable to make report
12/24/22	GA Pilot	Important, if ADSB weather is not available in flight
12/29/22	Part 121 Pilot	I love the website interface!
1/3/23	GA Pilot	Cuts off first word or last
1/8/23	GA Pilot	The delay between submission and being available for retrieval on the website is long. This could be an issue when dealing with rapidly changing weather conditions in areas.
1/8/23	GA Pilot	The location of the symbols (headsets indicating a pirep) on the map don't seem to always match the report. Today, for example, there is one report that says '15 miles south of Will Rogers and the little headset image for that one actually shows NE of the airport symbol for OKC. Just an interesting observation of the map on website for PIREP

Date	Type of Operation	Comment
		retrieval. Difficult to hear the difference between 15 and 50 if pilots are not saying each number individually (fifteen sounds like fifty).
1/12/23	Part 121 Pilot	The voice to text translation still needs some work. However, the audio playback makes up for that shortcoming. I also think that the system has been doing a better job lately of deciphering what I have been saying when I check the website at home to see how it did.
1/15/23	Student Pilot	Sometimes the location of the PIREP on the map is not the location that is being called out in the PIREP.
1/17/23	GA Pilot	The PIREP's actual location as placed on the map and the location stated in PIREP are totally different. For example, PIREP on map is shown inside TFR. Sometimes type aircraft is missing. Alaskan problem. The internet is only available about 30NM from Fairbanks or Nenana ie 90% of Alaska doesn't have internet coverage period. This system is web base and therefore not available to pilots outside the main airports.
1/21/23	Part 135 Pilot	I've had a difficult time viewing my PIREP
1/22/23	GA Pilot	Misplaced PIREP showing at "OKC" rather than their proper location. Location is key in usefulness of reports. Audio far outweighs only referencing the decoded report.
1/22/23	GA Pilot	I enjoy checking the website. I think it works well.
1/26/23	GA Pilot	I appreciate hearing the actual recording. So much can be gleaned from the pilot's voice.
1/26/23	Part 121 Pilot	The audio playback is essential, just in case the voice to text transcription did not pick everything up. Plus, it provides another level of completeness to the PIREP when the pilot hears it firsthand from another pilot, versus by reading it, or hearing it second or thirdhand from an ATC controller.
1/29/23	Student Pilot	I enjoy being able to use the mobile app to retrieve PIREPs.
1/31/23	GA Pilot	No internet after 30NM from PAFA. Cannot access internet in villages
2/2/23	GA Pilot	Audio is great. There are some gaps in audio occasionally.

Date	Type of Operation	Comment
2/4/23	GA Pilot	Audio playback is always helpful.
2/5/23	GA Pilot	I enjoy the ability to actually listen to the PIREP
2/9/23	GA Pilot	Still having plotting problems but getting better.
2/9/23	Part 121 Pilot	The website interface is great. I like how it still puts the PIREP in the OKC area, even if it did not interpret the exact position correctly. In the operational system, you could link the PIREP to the individual antenna that receives the report and have it default to that region even if the exact position isn't recorded. It will still be helpful when the pilot clicks on it and it will make sense to the pilot when they hear it.
2/12/23	Student Pilot	I really enjoy having the mobile app. It makes it really easy to quickly look up any PIREPs in the area.
2/14/23	GA Pilot	Again, you need to be under the Internet Vail to use in Alaska. Alaska cell phone roaming Vail is poor. I wish once we touch a PIREP and read it, it becomes highlighted on the map so I know I reviewed it and can count my PIREPs. I see most of my PIREPs not to be confused with all of them. The system prints out crazy phrases that do not match a clear voice stating otherwise.
2/18/23	GA Pilot	Works well and can tell what's happening with the weather before taking off.
2/19/23	GA Pilot	Excellent preflight capability to get real-time reports of inflight conditions.
2/19/23	GA Pilot	Audio playback is good, however the map can be challenging to use and several PIREPs tend to get stacked on top of each other, making them difficult to find. A list view may be beneficial. Also, a dashboard that shows any one user all of their submitted PIREPS and retrieval request would be helpful to allow tester to more easily evaluate their submissions/retrievals for accuracy.
2/21/23	Student Pilot	Good to hear what I'm saying
2/23/23	GA Pilot	Very nice to hear the actual report. Voice inflections reveal a lot about the actual conditions.

Date	Type of Operation	Comment
2/23/23	Part 121 Pilot	The audio playback is very good. Sometimes it seems like when I retrieve, it gives me PIREPs that were submitted near other airports instead. Possibly the system did not correctly interpret the location where the other PIREPs were submitted, or it did not correctly identify the location that I asked for. I have been using the phonetic spellings of the airports in my requests- Oscar-Kilo-Charlie, etc.
2/23/23	Student Pilot	Not extremely useful as apps like foreflight do the same thing without needed the voice feature. The voice to text is inaccurate at times.
2/24/23	GA Pilot	No complaints here other than not seeing all submitted experimental PIREPs after flying
2/26/23	Student Pilot	The audio comes back clear.
2/26/23	CFI	I didn't know we could do it over an app so haven't done that.
2/28/23	GA Pilot	Again Alaska area of internet signal is very small
3/1/23	Student Pilot	The online system was great to use during bad weather days to really determine if icing conditions were present
3/2/23	Part 121 Pilot	Don't really need web audio playback, transcription is fine.
3/3/23	Part 135 Pilot	Audio playback of the PIREPs gives the most accurate interpretation. Some of the text is not translated properly. Audio is better to listen to and get a more accurate report.
3/3/23	GA Pilot	I was sitting trying to make a decision on my go/no-go the other day and I thought to myself, "wow, this really would be incredibly beneficial to have this as a legal means of weather." Because the clouds were overcast 1,500 and I wanted accurate temp readings.
3/4/23	GA Pilot	I am surprised how well it is to retrieve data and defined to where you actually are.
3/4/23	Part 121 Pilot	These feature worked for me and I found it quite useful. Though by the time I was on the ground where I could check the website, it was too late or old information.
3/5/23	GA Pilot	This is perhaps the glowing gem of the retrieval system thus far. Very useful in preflight preparation!

Date	Type of Operation	Comment
3/5/23	Part 121 Pilot	I have not retrieved too many PIREPs from the mobile app but the website was clear and easy to use.
3/5/23	GA Pilot	This is very useful since the voice to text transcription is not always correct or understandable.
3/7/23	GA Pilot	The info should open up when I hover over the report on the map. Each time I have to click to read it, moves the map to a new location and then I have to re-orient it to make sure I'm viewing all the reports of interest.
3/9/23	GA Pilot	Until the system is almost perfect it is imperative to keep the audio file available so we can listen to what was actually said.
3/9/23	Part 121 Pilot	The audio playback is the strongest part of the system. It is very helpful.
3/9/23	Part 135 Pilot	I would use this system mostly on the ground for preflight, and I think the text translation would be much more useful here. Based on the current ability of the computer to interpret the audio to text, however, having the audio backup is great.
3/10/23	GA Pilot	No issues here, straight forward
3/10/23	Part 121 Pilot	Works great!
3/11/23	GA Pilot	Love using the site how it maps the locations of the reports
3/12/23	Student Pilot	The audio playback feature is nice to have in case the system incorrectly converts voice to text. This way you can hear what was spoken originally.
3/13/23	GA Pilot	Need to stop if or when asked/told. It just goes on and on.
3/14/23	GA Pilot	On the ground excellent. In the air not so good
3/15/23	Part 135 Pilot	I like that I can hear the pilot's PIREP from the ground and be shown the exact location on the map. Very practical in the future when it can be integrated on the weather camera site.
3/16/23	Part 121 Pilot	Again I might only use this to verify audio to text but don't typically play audio if I don't have to.

Date	Type of Operation	Comment
3/16/23	Part 121 Pilot	I would not listen to a PIREP in my preflight briefing when a text version is available. Audio just doesn't seem practical in most scenarios.
3/17/23	Part 135 Pilot	Audio playback via mobile app is a good option to correct any misinterpretations from the voice to text transcription.
3/18/23	GA Pilot	The voice to text needs work but the best is just listening to the audio playback. I can normally understand it by only taking 15 to 25 seconds to check the weather.
3/18/23	GA Pilot	List view would be helpful
3/19/23	GA Pilot	This combination of technology may be the most viable as end user retrieval of direct voice recording is free from computer transcription errors.
3/21/23	GA Pilot	I need a fast hover capability to see which reports are mine quickly
3/23/23	Student Pilot	I have not used the mobile app.
3/26/23	Student Pilot	Sometimes the system will place the PIREP in the wrong location on the map.
3/28/23	GA Pilot	Again, this program is based on having internet available. When internet is available system works great. In Alaska internet is only available to bigger communities. Only 8% of Alaska has internet capabilities. That's the weak link in this system.
3/29/23	Part 135 Pilot	Good feature, hopefully this will be put in the FAA Weather cameras site.
3/30/23	Part 121 Pilot	Still don't really use audio playback, just read text.
3/30/23	Part 121 Pilot	Sound recording is not necessary for PIREP retrievals. I prefer the normal text version.
3/31/23	Part 135 Pilot	The voice to text translation seems to be intermittently good. Some text translations leave alot to be desired and you have to listen to the pilot audio to be able to interpret.

Date	Type of Operation	Comment
4/1/23	GA Pilot	I have a few problems using my iPhone SE and trying to click on the PIPEP icon and the screen just blanking out, but if it works there are easy to understand.
4/4/23	GA Pilot	We need a better way to sort and search audio PIREPS.
4/6/23	Student Pilot	I have not retrieved using the website or mobile app.
4/6/23	Student Pilot	I did not use the website for retrieval.
4/12/23	Part 121 Pilot	Not useful for airline ops as no wifi connection.
4/15/23	GA Pilot	Website good but mobile app not as good. Could be my phone version or not.
4/20/23	Student Pilot	Did not use
4/29/23	GA Pilot	Not working very good anymore

Appendix F

Pilot Participants' Comments: Retrieval via Website/App (Voice-to-Text)

Date	Type of Operation	Comment
11/29/22	GA Pilot	I'm not sure I understand this but I think this is supposed to be translating audio to text. It doesn't appear to be working, right?
12/1/22	GA Pilot	Have not used in depth
12/1/22	GA Pilot	Although the computer is improving, there are still a lot of errors in translations.
12/5/22	GA Pilot	Once this is pushed out to other systems like foreflight I think it will greatly aid pilot decision making.
12/13/22	GA Pilot	Difficulty when having to transcribe
12/13/22	GA Pilot	The voice-to-text compared to audio is still missing some numbers and has errors. I would not use it as a reliable source of PIREP.
12/13/22	GA Pilot	I don't think this is working yet
12/14/22	GA CFI	Ok
12/19/22	GA Pilot	Unable to make report
12/22/22	Part 121 Pilot	Some words are mis-transcribed. I'm sure that will improve as the system learns and you make tweaks.
12/24/22	GA Pilot	It is easy to access the transcriptions, but they are currently untrustworthy and could be dangerous with faulty interpretation of pilot. The transcription part is having serious problems correctly interpreting, as you are aware. I have learned that best practices for me is to avoid necessary pauses while reporting, so pre-writing the report will help the AI better understand the language.
12/27/22	GA Pilot	I hear "clear skies" and see transcribed as 'clears guide' as well as 'smooth ride at my level' transcribed as 'smooth ride if my level'. Some of the transcription is spot-on, though!
12/29/22	Part 121 Pilot	The website is great! The voice to text translations need some work, it routinely misinterpreted words.
1/3/23	GA Pilot	Makes up words

Date	Type of Operation	Comment
1/5/23	Part 121 Pilot	Some words/terms are still being mis-transcribed
1/8/23	GA Pilot	Audio quality is very good. Transcription is sometimes slightly off.
1/8/23	GA Pilot	The voice-to-text transcriptions seem to be getting better, although many of them still make me laugh :)
1/12/23	Part 121 Pilot	The graphical interface is excellent. Being able to click on the area where I will be flight planning and listen to the firsthand account is really nice. This could really improve aviation safety with regard to flight planning and weather avoidance. A pilot only gets half of the story by looking at prognostic charts and radar/satellite images prior to flying. This user interface is great if it could be rolled out for everyone to use.
1/15/23	Student Pilot	The system has a hard time interpreting some words. Typically airport or city names.
1/17/23	GA Pilot	Correct word interpretation is still a problem especially like "Lower ground Clouds two to four thousand feet below." The system struggles with "two" the number and "to" the word. This portion has been directly affected by Alaska chronic poor web coverage issue. Looking back at my PIREPs I can figure out what was said, however some PIREPs by other pilots I cannot.
1/22/23	GA Pilot	Many errors in transcription compared to the audio recorded.
1/22/23	GA Pilot	I think the system is definitely getting better at decoding the audio into text.
1/26/23	GA Pilot	Lots of translation errors but getting better.
1/26/23	Part 121 Pilot	I can tell that the system is improving it translations. Having the audio clip available is very helpful to double check the intended meaning.
1/29/23	Student Pilot	Sometimes the system will not understand a word correctly. Typically this happens with airport names.
1/31/23	GA Pilot	Again 95 percent of rural Alaska has no internet available
2/2/23	GA Pilot	Perhaps weakest part of the system. Recent use of alphabet helps.

Date	Type of Operation	Comment
2/5/23	GA Pilot	It is a regular occurrence that some reported conditions are not caught by the automated system. For example, a submission may include "skies overcast 5,500. Visibility ten miles" and one of the two reports will not be transcribed to text.
2/5/23	GA Pilot	I notice that some phrases are always tricky for the computer to translate. For instance, "winds aloft" usually gets interpreted in an amusing way. It's still helpful to have the text.
2/8/23	GA Pilot	Some remarks were nonsensical
2/9/23	GA Pilot	Lots of errors but getting better.
2/9/23	Part 121 Pilot	The voice to text still has a few wrinkles, but when I announce my PIREP as clearly as possible and articulate, the system seems to do a better job of picking up my correct words. Users will just need to be sure to annunciate and articulate their syllables when talking to the automated system and I think it will do great.
2/10/23	GA Pilot	Fair amount of mis-translation
2/12/23	Student Pilot	It seems the system gets most caught up turning the voice interaction into text when referencing the location and airport name.
2/14/23	GA Pilot	There's no doubt the system works, however the system randomly inserts words and phrases that were not even remotely in the voice recording nor applicable to the immediate subject. If a person plays back the voice recording then reads the text I can understand the PIREP
2/18/23	GA Pilot	Most are good but it has its limitations when listening.
2/19/23	GA Pilot	Voice transcription accuracy will be the determining factor on how well the voice submitted PIREP system performs long term.
2/19/23	GA Pilot	Voice transcription seems to be getting better.
2/23/23	GA Pilot	Funny to see how the computer interprets some of the audio. This is getting better.
2/23/23	Part 121 Pilot	The graphical depiction of the PIREPs on the website is super helpful. The voice to text is still improving. I haven't seen "vegetable turbulence" in a little while so I think it is improving a little bit. Even if it incorrectly translates the word, through context clues I am able to

Date	Type of Operation	Comment
		figure out what it meant. Then I can always listen to the audio clip for clarity just to make sure.
2/23/23	Student Pilot	Voice interpretations were often incorrect.
2/24/23	GA Pilot	When there's lots of PIREPs submitted in the same area, choosing a specific one can be difficult. Some of the words/sayings the system is having issues putting in to text: turbulence, 2 vs to, system mixes and matches numbers together when read separately. eg "cloud layer at 7000 to 8000" transcribes to "7002 8000"
2/26/23	Student Pilot	The system has a difficult time converting voice to text for airport and city names if they are unique.
2/28/23	GA Pilot	No internet no mobile app
3/3/23	GA Pilot	I'm sure I don't need to add too much here. The AI just needs time to transcribe better.
3/3/23	Part 135 Pilot	It appears that the text doesn't always follow the PIREP as recorded Words are incorrectly translated and meanings are not always clear.
3/4/23	GA Pilot	I think when everyone is using KOKC to define their searches makes harder to define the data.
3/5/23	GA Pilot	Some refining of voice to text is still needed.
3/5/23	Part 121 Pilot	The voice to text transcription is as good as the user makes it. Speaking clearly with intent makes it work well.
3/5/23	GA Pilot	I had hopes that the voice-to-text transcriptions were getting better, but I find it still can't translate simple, often repeated phrases like "No Remarks" correctly. In fact, "No Remarks" gets translated correctly very rarely. It also can't translate simple things like the correct number of miles from an airport and many local airports continuously get translated as very strange words, even though these airports and stated again and again. Even when using the airport identifier, it does not place the aircraft in its correct location.
3/7/23	GA Pilot	Works fine
3/9/23	GA Pilot	Funny what words the system still has problems with.

Date	Type of Operation	Comment
3/9/23	Part 121 Pilot	I thought the voice to text translations were getting better, but now I am not so sure. I think that the success in translation lies in the pilot using standard and predictable jargon and avoiding colloquialism use and aviator slang. Judging by the locations of the PIREPs, I can tell that some of the worst system performance on the transcriptions are from student pilots around the OU area. As they get more experience in their careers, they will get better at giving PIREPs to ATC. Again, a user guide would be beneficial if the system is catering to the general aviation community, where the average pilot may not have much experience speaking in phonetics, or giving PIREPs to ATC.
3/9/23	Part 135 Pilot	If the transcription becomes more accurate, this will be my preferred way to receive the PIREPS and can more easily by integrated into the current NAS and pilot app systems.
3/9/23	Student Pilot	Website is very helpful and easy to use
3/10/23	GA Pilot	There's some room for improvement on accuracy of voice to text. I'd bet this is the most difficult, "teaching" the system. Even Google with all their infinite money can't get this right. I'm guessing eventually these PIREPs will end up on ForeFlight, seeing this in text will be huge.
3/10/23	Part 121 Pilot	Some small transcription errors by the software "Five Zero miles" outputting as "5 miles". The audio is correct though
3/11/23	Part 135 Pilot	The system seems to be having some trouble understanding some of the calls. It makes for some funny text versions of the PIREPs but not very useful.
3/11/23	GA Pilot	Never used, not sure how to use it
3/12/23	Part 135 Pilot	Doesn't translate well to text
3/12/23	Student Pilot	The system does not recognize all airport/town names when converting to text format.
3/13/23	GA Pilot	Voice is easy to hear and understand but won't stop.
3/14/23	GA Pilot	Great however this is if the linguistic problem gets resolved

Date	Type of Operation	Comment
3/17/23	Part 135 Pilot	Voice to text transcriptions are not always accurate as to what was stated. Interpretation of some words seems to be dependent on the proper language used in giving the PIREP. If the pilot does not have good diction and pronunciation of some words, the translation seems to be off. I see a need for improvement with the interpretation to text.
3/18/23	GA Pilot	This needs a little work but it is fun look at the transcription and then listen to the recording to see what was really said. I use an iPhone and it does seem to get lost when moving around on the screen. Works a little better when using my iPad.
3/18/23	GA Pilot	Could be good, but AI translations continue to be problematic
3/19/23	Part 135 Pilot	The voice to text is probably the most useful part of the system. Although the transcription is very inaccurate.
3/19/23	GA Pilot	Inaccuracies are numerous in transcriptions. The general pilot population using the system will not have months to practice interacting with the system and thus interpretation capabilities should be flexible. "Ten" and "one zero" should both be transcribed as the number 10. A system that demands unique phraseology outside of common radio communication practices is not a viable solution.
3/21/23	GA Pilot	Works generally ok. I made some vocal mistakes which makes my comments harder to interpret.
3/23/23	Student Pilot	I have not used the mobile app.
3/23/23	Part 121 Pilot	I did not use the mobile app
3/23/23	GA Pilot	Getting better at interpreting but still needs improvement.
3/24/23	GA Pilot	Voice to text translation will always have some discrepancies but can use some improvement
3/26/23	Student Pilot	The system has a hard time converting town and airport names to text.
3/30/23	Part 121 Pilot	Occasional transcription errors. (Siri doesn't understand me very well either)

Date	Type of Operation	Comment
3/31/23	Part 135 Pilot	The accuracy of the voice to text seems accurate sometimes and misses the boat on other occasions. The pilot audio is a must to be able to verify text transcription.
4/1/23	GA Pilot	I have a few problems using my iPhone SE and trying to click on the PRPEP icon and the screen just blanking out. I always check my PIREP after I get back to the airport to see how my PIREPs turn out and how they are translated.
4/1/23	GA Pilot	Still flawed AI interpretations at times. Could be problematic
4/2/23	Part 135 Pilot	If the voice to text feature was improved it would be very useful, however it is frequently wrong
4/4/23	GA Pilot	This feature needs to be like the Garmin PTC (push to command) feature. I should be able to click an area and have it playback all relevant PIREPS
4/6/23	GA Pilot	Voice to text seems to have gotten worse rather than better.
4/6/23	Student Pilot	I have not used this yet.
4/6/23	Student Pilot	I did not use the voice to text transcription
4/12/23	Part 121 Pilot	Not useful for airline ops
4/15/23	GA Pilot	This does need some work. It could be the way a speak accent wise. It does have some funny translations. I like to listen to mine and others just to see what to transcribes.
4/16/23	Part 135 Pilot	Would be very useful, but currently the voice to text transcription is dangerously inaccurate. Often times the text transcription is unreadable when the recording sounds easily understandable.
4/20/23	Student Pilot	Did not use
4/23/23	Part 135 Pilot	The AI continues to struggle with the correct translation of voice to text
4/29/23	GA Pilot	About the same

Appendix G

Pilot Participants' Comments: Retrieval via Website/App (Plain Text)

Date	Type of Operation	Comments
11/17/22	GA Pilot	It is not very good at interpreting aviation terms and Alaska locations.
12/1/22	GA Pilot	Nice to be able to see exactly what I want when looking and not having to scan through the voice to text.
12/6/22	GA Pilot	Sometimes text interpolation was incorrect
12/13/22	GA Pilot	I'm not sure I understand this but I think this is supposed to be translating audio to text. It doesn't appear to be working, right?
12/13/22	Part 121 Pilot	Conducted 2 PIREPs this on 12/11/22 system is working as designed
12/13/22	GA Pilot	I don't think this is working yet
12/14/22	GA CFI	Have not tried this feature yet
12/15/22	GA Pilot	Have not used in depth
12/19/22	GA Pilot	Unable to make report
12/20/22	GA Pilot	If I land back home in Fairbanks and get back on the internet this system would be great. However, some villages 50NM away can't get on internet.
12/24/22	GA Pilot	It is easy to access the transcriptions, but they are currently untrustworthy and could be dangerous with faulty interpretation of pilot. The transcription part is having serious problems correctly interpreting, as you are aware. I have learned that best practices for me is to avoid necessary pauses while reporting, so pre-writing the report will help the AI better understand the language.
12/27/22	Part 121 Pilot	Did not use
12/29/22	Part 121 Pilot	The voice to text needs a little work, but a great concept if that part can get worked out!
1/3/23	GA Pilot	Makes up words
1/8/23	GA Pilot	I enjoy checking the website before I go flying.

Date	Type of Operation	Comments
1/12/23	Part 121 Pilot	The machine is still learning how to decipher what is said verbally. Perhaps part of the problem is non-standard terminology that is commonly used in aviation such as "occasional light chop" versus "light turbulence". If the system rolls out, perhaps it could be handy to include a short cheat sheet for the pilot to be able to refer to refresh them on what possible words the computer is expecting to hear during the Pilot Report. This is a wonderful system. If there is any particular verbiage or reports that you would like me to test on the system, feel free to let me know. Thank you for the opportunity to be a part of this amazing project.
1/17/23	GA Pilot	This is working pretty good except when specific words are not the pilots intended word. For example, airports like Nenana, Gold King, Healy River, Manley. The word "till" is printed instead of tail wind. Gaul king is printed instead of gold king. Few clouds is pew. Would like to use the acronym VFR, MVFR, IMC only in remarks section.
1/29/23	Student Pilot	Sometimes the system will not understand a word correctly. Typically this happens with airport names.
2/2/23	GA Pilot	Combined with voice to text, this area is still very weak.
2/5/23	GA Pilot	Helpful to have the plain text to read.
2/9/23	GA Pilot	Some of the problems are that the system is not smart enough to understand what we mean and other times it just plain gets what is said wrong. It is getting better though.
2/9/23	Part 121 Pilot	It's super easy to use and the visual display on the map is very helpful. In the operational system being able to superimpose a radar display and satellite imagery display on the map will really result in an uptick in pilot usage because everything will be right there! Plus, the TFR overlay is very helpful and I really like that you included that button on the user interface map as well.
2/14/23	GA Pilot	As a pilot I need to review any and all info available. Reviewing the Plain text and listening to the voice recorder allows me to see the big picture without further questions. With proper training I think a single pilot IFR/VFR with an auto pilot could use this system in flight. Provided he can get cell roaming coverage. Using

Date	Type of Operation	Comments
		four letter identifiers for airports was a large step forward both in stating location and retrieving within 30 miles of location.
2/18/23	GA Pilot	It seems like the altitude does not become transcribed correctly maybe due to the method of pilots stating altitude. Like saying 2500 foot or 2 5 0 0.
2/23/23	GA Pilot	Nice to have the full transcript.
2/23/23	Part 121 Pilot	The plain text translation is still needing a little bit of work. Sometimes is interprets the PIREP words as totally different words. This shortcoming is more than made up by having the audio file right there that you can listen to. I also find that the system does not like it when I say "One-Two-Thousand", instead of "twelve-thousand". Speaking to an ATC controller, for clarity's sake I would normally use "one-two thousand". If that one little translation issue could get rectified, then I think the accuracy of the system's translation performance would exponentially increase.
2/23/23	Student Pilot	Voice interpretations were often incorrect.
2/24/23	GA Pilot	Some of the same issues as above in the transcription but doesn't appear to be as frequent.
2/26/23	Student Pilot	The system has a difficult time converting voice to text for airport and city names if they are unique.
2/26/23	Part 135 Pilot	Several were lost in translation.
2/28/23	GA Pilot	It useful until the text / interpretation goes off the rail.
3/1/23	Student Pilot	The app only works if you have WIFI.
3/3/23	Part 135 Pilot	As long as the text is translated correctly, it is a quicker method to retrieve the PIREP.
3/3/23	GA Pilot	I'm putting a 3 across the board because to be honest, I cannot remember what this is or what this question is asking. So I am just putting 3's as a baseline average. I used the website and enjoyed seeing if my friends and I's PIREPs picked up and were transcribed properly.
3/4/23	GA Pilot	I actual think this is the best way to retrieve the data.

Date	Type of Operation	Comments
3/5/23	Part 121 Pilot	I love the website for PIREP search and retrieval. It's easy to use and the legend shows clear icons for identification. I did notice that the PIREPs I had submitted were not in the system shortly after I put them in. I assume there is a little time lag and authentication that needs to be done. Love the format. I use this more than the other avenues of PIREP retrieval.
3/5/23	GA Pilot	Until the system can correctly translate simple phrases, the audio playback seems to be the only practical implementation.
3/7/23	Student Pilot	Very useful program. Love it
3/7/23	GA Pilot	I stuttered on my call orienting near Tinker, but the interpretation figured it out properly.
3/9/23	GA Pilot	Some things never fit into the normal PIREP template. Nice to have this functionality.
3/9/23	Part 121 Pilot	The website is a real strong point of the program. I enjoy reading and listening to the reports and getting an idea for how the weather is in the area, and how the system is doing.
3/9/23	Part 135 Pilot	I'm not sure how this is different than the voice to text translations but condensing the information from the voice into the normal PIREP format in plaintext would be beneficial to help current systems like Foreflight interpret the data and present it in the cockpit over ADS-B.
3/11/23	GA Pilot	Never used not sure how.
3/12/23	Part 135 Pilot	Doesn't translate well to text.
3/12/23	Student Pilot	The system does not recognize all airport/town names when converting to text format.
3/13/23	GA Pilot	Gives the same thing for different airports and mileages
3/14/23	GA Pilot	Again great while on the ground
3/16/23	Part 121 Pilot	I like the ability to review. It would be nice to modify with a login to make corrections due to time constraints in flight.

Date	Type of Operation	Comments
3/17/23	Part 135 Pilot	The retrieval on the app seems to be working good. Locations of calls appear accurate to the information given by the pilots. It is quick and easy to access PIREPs for the area desired as geolocated on the icons
3/18/23	GA Pilot	Works well on my home computer. Screen doesn't get lost like my iPhone. When I leave a PIREP I listen to it while I am still flying to make sure it took it, then check it back at the airport on my iPhone to see what it interpreted it as, and then check it on my computer after I get home to see what others were reporting around the same time.
3/21/23	GA Pilot	Works generally well
3/23/23	Part 121 Pilot	I did not use the app.
3/23/23	Student Pilot	I have not used the mobile app.
3/24/23	GA Pilot	Voice to text translation will always have some discrepancies but can use some improvement
3/28/23	GA Pilot	Great preflight tool
3/30/23	Part 121 Pilot	Not sure I'm seeing all my PIREPs submitted. Will keep closer track next month.
3/31/23	Part 135 Pilot	The accuracy of the plain text needs to get better. I listen to various pilots talking and leaving PIREPs. Some speak clearly and use normal terminology; others are not so clear and use nonstandard descriptions of weather and associated phenomena. More pilot training and experience will yield better results in the long run.
4/1/23	GA Pilot	Work good but needs some work in the translation almost always need to listen to the recording to figure out what it really is reporting.
4/4/23	Student Pilot	The more I use this system I realize how hard it can be to listen for my que to add to the PIREP or submit or retrieve, etc while also listening to whatever center frequency I'm on. I might just be worrying too much about missing a call but the automated voice is too slow and can be hard to understand at times.

Date	Type of Operation	Comments
4/4/23	GA Pilot	What if we listed the PIREPS in addition to showing them as icons on a map. Perhaps we add a directional arrow showing the relative location of the report to where the user selected.
4/6/23	GA Pilot	Wish we had a more accurate system to convert the speech to text.
4/6/23	Student Pilot	I have not used this yet.
4/6/23	Part 121 Pilot	It's a very easy system to use the only thing is the automated system doesn't always accurately pick up what we say. Other than that the systems is working great!
4/7/23	Part 121 Pilot	Some incorrect info in the text transcriptions
4/12/23	Part 121 Pilot	Recommend for GA use only
4/15/23	GA Pilot	This seems easy to use better on my computer than my phone.
4/20/23	Student Pilot	Did not use
4/23/23	Part 135 Pilot	The AI continues to struggle with the correct translation of voice to text
4/29/23	GA Pilot	Works good