Industry Perspective of Weather Technology in the Cockpit (WTIC) Program Pilot Industry Survey

This research is in response to requirements and funding by the Federal Aviation Administration (FAA) NextGen Weather Technology in the Cockpit Program. The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.

Tenny Lindholm

National Center for Atmospheric Research

FPAW Spring 2023 Meeting, 16 May 2023

NCAR | RESEARCH APPLICATIONS LABORATORY

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

Our Agenda

- Survey purpose
- Survey basics
- Responding pilot demographics
- Cockpit weather baseline now
- Suggested areas of future research from pilot responses
- Wrap-up and questions

Why the Survey?

Weather Technology in the Cockpit (WTIC) has significantly improved inflight access to updated weather information over the last 10 years. Now…

We want to baseline the current capabilities, and identify actionable opportunities for future research that will take advantage of new technologies, further improving the use of inflight weather information for decision support.

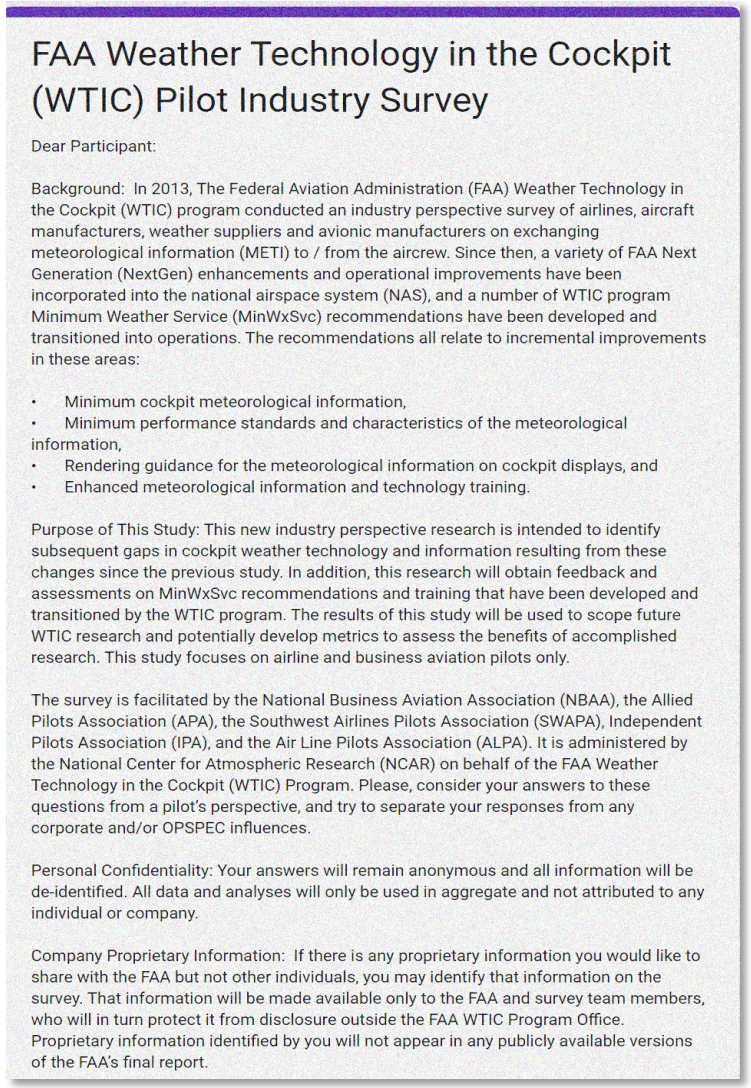
Survey Objectives

- Identify gaps, benefits, and impacts associated with
  - Weather information decision support.
  - Route availability planning and metering.
  - Use and availability of turbulence decision support information.
  - Airborne weather radar information.
  - Timeliness of airborne weather updates.
  - Take-off and landing performance assessments (TALPA)—for example, runway condition, braking performance.
  - Terminal and enroute icing information.
  - Wind information, with and without FMS.

Industry Participants

The above were actively involved during survey development and implementation.

Final Report completed 30 June 2022. 180 responses from CFR Parts 121, 135, and 91 pilots.



FAA Weather Technology in the Cockpit (WTIC) Pilot Industry Survey

Dear Participant:

Background: In 2013, The Federal Aviation Administration (FAA) Weather Technology in the Cockpit (WTIC) program conducted an industry perspective survey of airlines, aircraft manufacturers, weather suppliers and avionic manufacturers on exchanging meteorological information (METI) to / from the aircrew. Since then, a variety of FAA Next Generation (NextGen) enhancements and operational improvements have been incorporated into the national airspace system (NAS), and a number of WTIC program Minimum Weather Service (MinWxSvc) recommendations have been developed and transitioned into operations. The recommendations all relate to incremental improvements in these areas:

- Minimum cockpit meteorological information,
- Minimum performance standards and characteristics of the meteorological information,
- Rendering guidance for the meteorological information on cockpit displays, and
- Enhanced meteorological information and technology training.

Purpose of This Study: This new industry perspective research is intended to identify subsequent gaps in cockpit weather technology and information resulting from these changes since the previous study. In addition, this research will obtain feedback and assessments on MinWxSvc recommendations and training that have been developed and transitioned by the WTIC program. The results of this study will be used to scope future WTIC research and potentially develop metrics to assess the benefits of accomplished research. This study focuses on airline and business aviation pilots only.

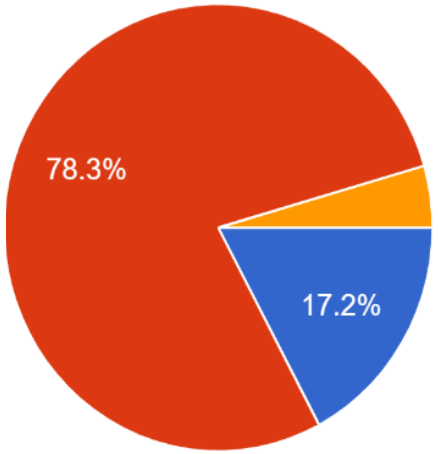
The survey is facilitated by the National Business Aviation Association (NBAA), the Allied Pilots Association (APA), the Southwest Airlines Pilots Association (SWAPA), Independent Pilots Association (IPA), and the Air Line Pilots Association (ALPA). It is administered by the National Center for Atmospheric Research (NCAR) on behalf of the FAA Weather Technology in the Cockpit (WTIC) Program. Please, consider your answers to these questions from a pilot's perspective, and try to separate your responses from any corporate and/or OPSPEC influences.

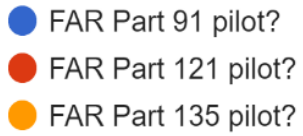
Personal Confidentiality: Your answers will remain anonymous and all information will be de-identified. All data and analyses will only be used in aggregate and not attributed to any individual or company.

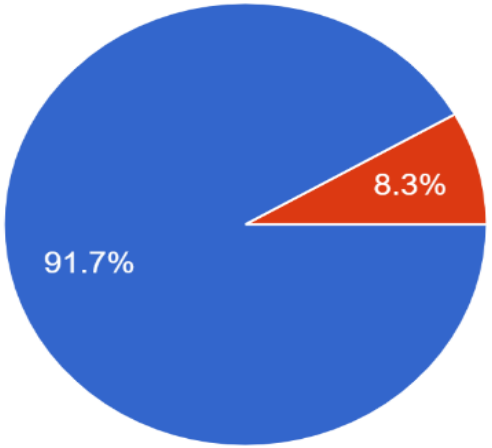
Company Proprietary Information: If there is any proprietary information you would like to share with the FAA but not other individuals, you may identify that information on the survey. That information will be made available only to the FAA and survey team members, who will in turn protect it from disclosure outside the FAA WTIC Program Office. Proprietary information identified by you will not appear in any publicly available versions of the FAA's final report.

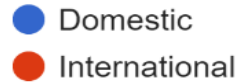
Pilot Survey Basics

- Automatic data collection and reporting
- On-line tool offered data, company, and individual security.
- Survey design tailored flow based on previous answers and demographics.
- Survey questions were mostly multiple-choice and/or free-form response; however, we received detailed written feedback which was captured and reported in the Final Report.







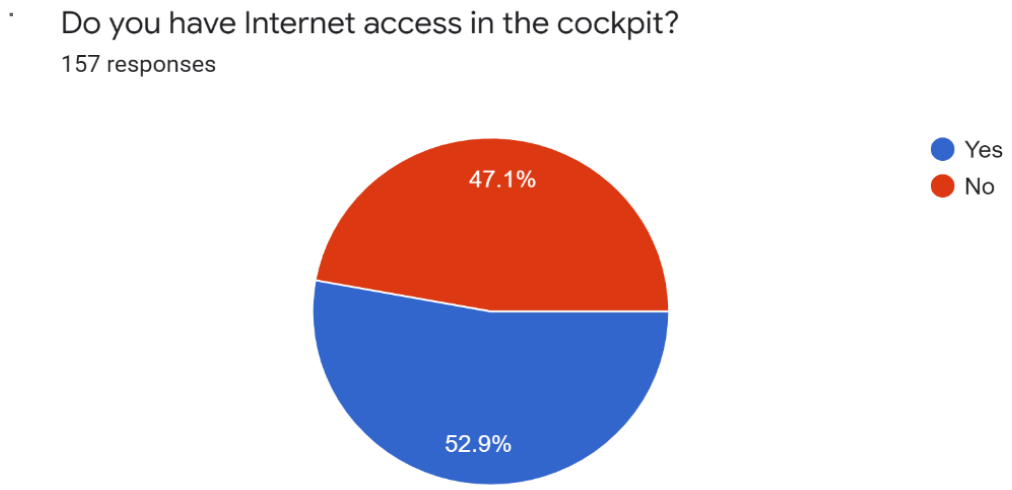


Responding pilot cross-section

- CFR Parts 135, 121, 91
- Corporate, air carrier passenger and cargo
- Charter and general aviation
- Mostly domestic operators
- Aircraft types from C-150 to B-747; all Boeing and Airbus types; 26 different aircraft types

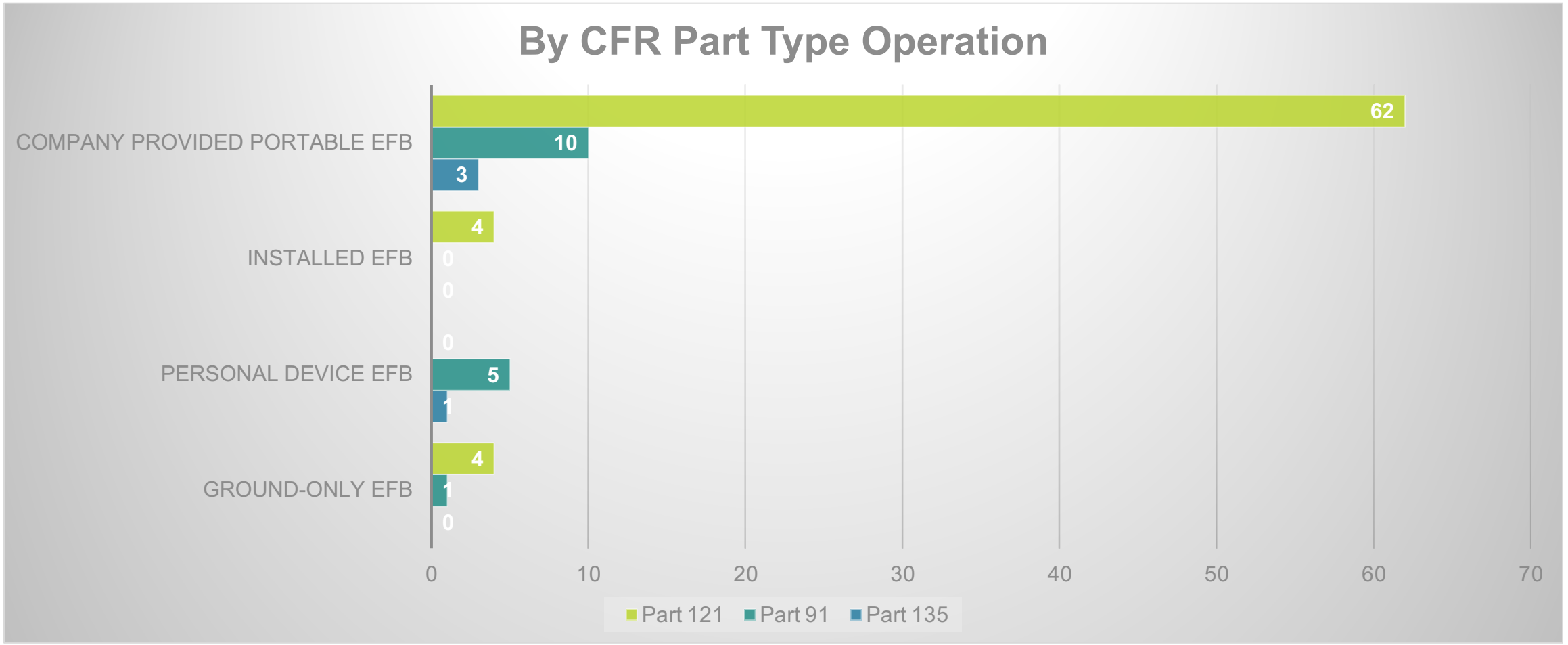
Summary of current capabilities—a baseline.

Internet Access on the Flight Deck

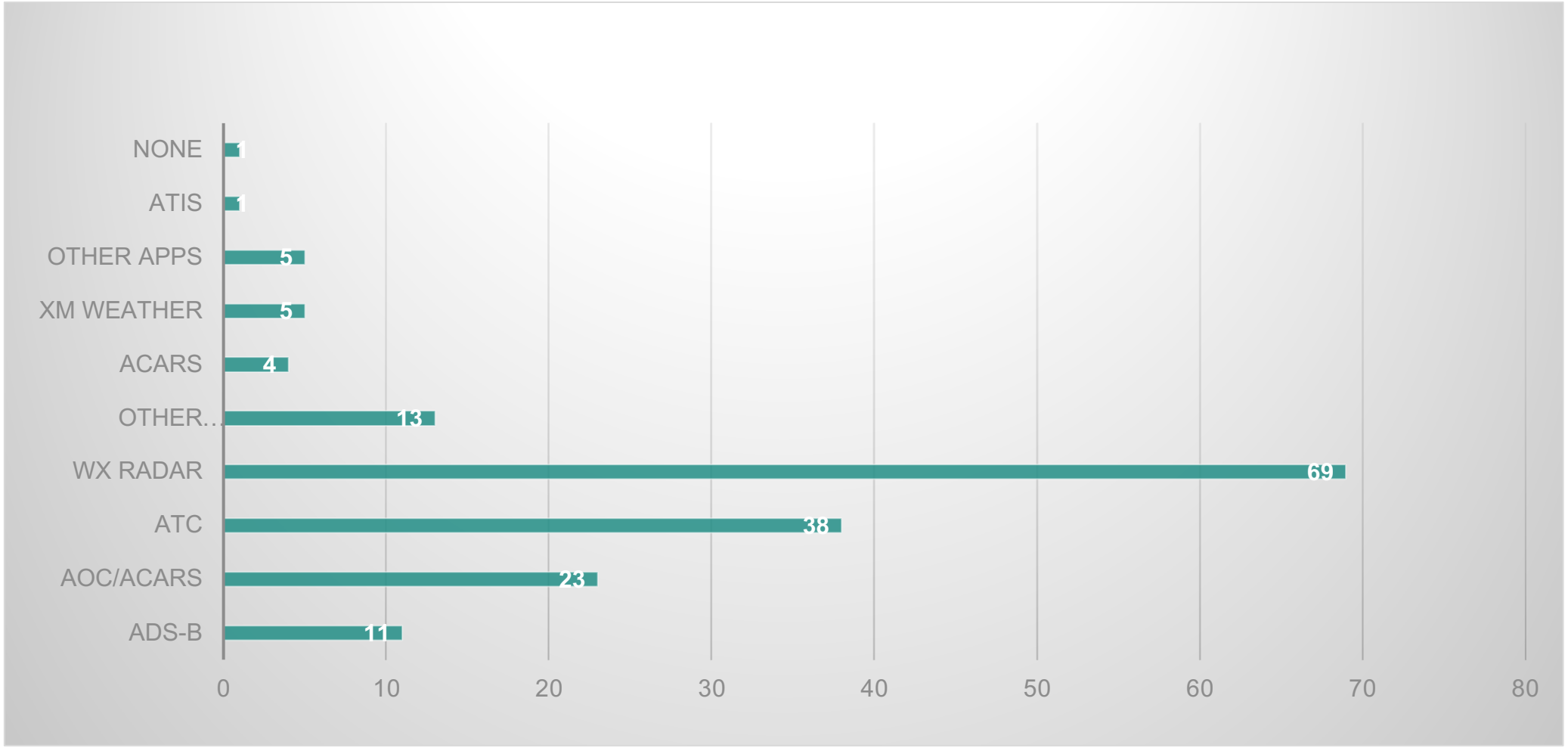


- 71 Part 121 pilots (51%) are able to use an EFB via the Internet inflight
- 17 Part 91 pilots (57%) are able to use *EFB functionality* via the Internet inflight. Note that Part 91 includes corporate operations.

Of Those with Internet on the Flight Deck…



Legacy Source “Fall-back”



Weather Update Capabilities

- Internet and EFB-capable flight decks could access these identified applications:
  - Delta Air Lines Widget Weather (formerly Flight Weather Viewer or FWV)
  - WSI Pilot Brief Optima (primary), Jepp FlightDeck Pro (secondary)
  - ForeFlight
  - CIWS website
  - SiriusXM
  - *AviationWeather.com* (Aviation Weather Center, AWC)
  - FlightAware

Internet Access and Type of Operation

- Almost all responding CFR Part 121 pilots depend on Wi-fi for Internet access.
- All CFR Part 91 (corporate and General Aviation, GA) pilots who claim to have Internet access do so directly via established networks (e.g., satcom, cell).
- Internet access is the key enabler to better inflight weather information update capability; Wi-fi from the cabin (Part 121) is the current tool for most airlines to access Internet-based applications.
- Therefore, pilots asking for better Wi-fi access to satisfy their need for better cockpit weather information are really asking for ***Internet access that is always there…***

The following slides summarize derived future research opportunities that were identified from survey responses. The goal is to improve today's initial capability.

Suggested Actionable Research

- Weather information must be decision- and/or task-driven.
  - Results suggest a complete decision and task analysis of pilots, AOC, and ATC—the “triad”—is needed.
  - Then, supporting decision-support information is identified for each task and decision.
  - Finally, access and training on the use of required information products is essential.

This is fundamental to all the following actionable research areas suggested by survey results. Most applicable to CFR Parts 121 and 91.

Suggested Actionable Research

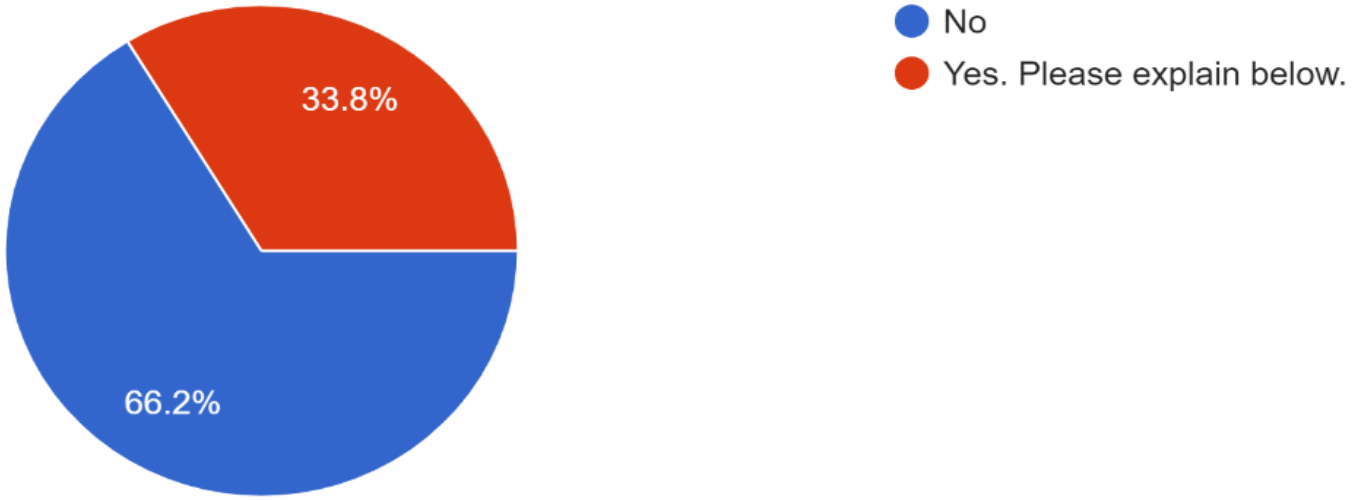
Where applicable for CFR Parts 121 and 91

- Pilot training assessments
  - Limits, interpretation, and operation of airborne weather radar.
  - Integrating and using weather information from different sources for the most benefit.
  - Use of weather information applications available on EFBs.
  - Use and limitations of available weather information products.
- Improvements to EFB applications (primarily addressing ease of information access, overlay confusion, and functional complexity)
  - Perhaps define application functionality within “minimum weather service recommendations.”

Consistency of Weather Information. Problem?

Have these inconsistencies created weather situation awareness confusion? If "yes," please explain below.

157 responses



Suggested Actionable Research

Most applicable for CFR Part 121 pilots

- The problem: Confusion, conflict, consistency issues when pilots are presented with disparate weather information from different sources
  - Nearly 60% of the pilots said that this is an issue. However, 35% say it negatively impacts decision-making.
  - Research is needed to understand and mitigate impacts of this problem.
  - Several pilots credit effective training and experience for mitigating problems associated with conflicting weather information from different sources:

"Newer pilots need to be educated about these topics. Current training in this area is not consistent and depends upon the initiative of the crewmember to self-educate."

Suggested Actionable Research

- Flight deck Internet accessibility and dependability
  - Research is needed on how to ensure *near-certain* Internet access on Part 121 flight decks.
  - Improving Internet access is the goal; wireless is only a currently available tool.
  - AID—Aircraft Interface Device via ARINC may be the way of the future.
- Research and FAA guidance needed to specify proper ways to access the Internet for Part 91 pilots.

WTIC and the FAA can only facilitate the research and needed infrastructure for Internet access in partnership with airline, corporate, and GA user groups.

Suggested Actionable Research

Applicable for all pilots

- Better understanding of decisions made and information required for all stakeholders. This includes intelligent updating of weather information only when it impacts a previous decision.
  - However, there is a point where decisions must be made and acted upon, so there is a tradeoff when frequent updates drive different decisions. This should be an active research area—when does frequently updated information become counterproductive for all players in the “triad?”
- Continue aviation weather research programs to address operational precision, forecast accuracy, real-time data assimilation, and update frequency. ***Precision and accuracy are important only when decisions are dependent on them.***

Suggested Actionable Research

Applicable for all CFR operations

- Common information for all stakeholders (pilot, ATC, AOC, AFSS)
  - "I want to plan. Give me the big picture and make sure AOC and ATC have the same one."
  - However, research needs to continually address the tradeoff between pure decision support for all stakeholders and information required to assure collaborative decision-making between all stakeholders.
- Research, rapid prototyping, and demonstration of a capability to graphically project a given weather hazard along an aircraft planned flight route
  - This potential product would also include the details of the hazard and decision support to help avoid or mitigate the hazard.

Suggested Actionable Research

- Pilots agree that there are just a few weather hazards that govern how their flights are conducted in a safe manner:
  - Convection, and associated hazards like turbulence, icing, lightning.
  - Other types of turbulence, such as windshear, clear-air, convective-induced, wake, mountain wave.
  - Inflight icing, in particular in the terminal area (Part 91) and enroute during Extended-range Twin-engine Operational Performance Standards (ETOPs) operations (Part 121).
  - Volcanic ash.

Satisfying information gaps relative to these hazards must focus on the decisions required; must support the cockpit, ATC, and AOC at the same time; and must not fall into the "nice to have" category in order to have the most impact. These concepts are a continuing area of active research.

Suggested Actionable Research

Mostly applicable to CFR Part 121 operators

- Pilots suggested an improved way of depicting EDR information, perhaps merged with model-based nowcasts that update very frequently and are presented graphically along an aircraft flight trajectory.
  - EDR data is similar to PIREP point data, difficult to use as a planning tool by itself.
  - Research can support development of training on use, limitations of, and access to Graphical Turbulence Guidance—Nowcast (GTG-n) product.
  - Finally, ensure updating is frequent enough to support decision-making.

Access to frequently updated turbulence severity and location (horizontal and vertical) information must always be available. Ease of access is a partnership between government and industry.

Suggested Actionable Research

- Pilots suggest a need for a capability to submit PIREPS via an application vs. voice.
  - Research is needed that supports the development of an application template and AI parsing of PIREP data for automated ingest into atmospheric models.

"We're on our iPad already looking at weather and working our flight plans. It seems very antiquated and tedious to submit a voice PIREP when a MUCH more detailed one could be only 5 or so clicks away."

Questions and Feedback

Bottom line: We are at an initial capability now. There are opportunities to improve and infuse weather information to better support needed decisions in the future.

Questions and Feedback

How can FAA WTIC Research Program further help you get weather information to the cockpit and AOCs? …timing, content, function, presentation,…

Is there anything that the pilot survey may have missed that the WTIC Research Program can address in the future?

Back-up Slides

The next slides summarize "raw data" responses from pilots. They include aggregate data as well as quoted comments from open-ended questions.

Pilot Responses

- Availability and dependability of flight deck Wi-fi capabilities need to be improved
  - Over 40 pilots reported that Wi-fi on the flight deck is sporadic and is not dependable. Most of these reports were from pilots flying more capable, larger commercial aircraft.
  - The potential impact to the overall WTIC capability is that pilots are still reliant on preflight information plus whatever voice or textual updates they can access from AOC, ATC, and other aircraft.
  - However, this limitation does not appear to be an issue that requires further research. The real issue is ***Internet access improvement.***

Pilot Responses

- There are opportunities for improvement and training on the design and use of the various weather information applications being used by airlines and corporate flight departments
  - Some applications available to pilots are difficult to use and understand.
  - Information is not presented relative to the aircraft's flight trajectory, which adds workload when the pilot is required to relate text or graphics to his/her location and planned route of flight. This comment summarizes the problems pilots encounter even though Wi-fi, well-intentioned applications, update capabilities, and (presumably) training are provided:

"Our *XXX* product is WAY too complicated to use and the layering functions easily allow you to mistakenly remove weather for other layers and miss important information."

Pilot Responses

- Research on better methods of collaborative decision-making between pilots, ATC, and AOCs are suggested so that everyone is aware of the reasons for routing, altitude, and diversion decisions: ***Airborne Reroute Information (ARI) and metering initiatives are addressing this issue.***
  - Pilots across the board want the actual weather information, not *just* decision support that tells them what to do. There is an optimal mix of raw information and decision support for each type of decision.
  - Pilots also want to know what ATC is planning and the information that forms the basis for those plans. Exception: There are times when pure decision-support is necessary. An example is a low-level windshear or microburst alert, either of which requires immediate actions by the pilot. Where pure decision-support is required or appropriate should be an area of active research.

Pilot Responses

- Information gaps were reported by pilots in terms of timeliness, information content, and presentation
  - Graphical depiction is important. Further, graphics need to relate to the 4-dimensional flight profile, current and planned. 4-D graphics include the time dimension, which can be graphically displayed using past-present-future looping to show movement and growth trends.

"For example, on a flight to Ecuador my dispatcher sent me a SIGMET with about 20 points that marked the boundaries. I spent about 20 minutes plotting all of the points, only to then figure out that the SIGMET did not cover any of my route but did extend 2000 miles all the way down to southern Chile. This would have been so much easier to figure out graphically."

.

Pilot Responses

- Weather forecasting research needs to continue to address precision and timeliness of inflight weather updates
  - Most weather information provided by inflight updates has an associated latency, and that will continue to be unavoidable. Delays associated with sensing, processing and communication will always be there. Some latencies, especially those associated with radar composite products, are at least 15 minutes.
  - Improvements in weather forecasting, including content, timeliness, and frequency of updates, are needed as reported by 30% of the pilots. Most mentioned was more frequent updates of turbulence information.
  - Pilots most commonly requested improved forecasts out to 4 hours.

Pilot Responses

- Airborne weather radar was identified as the best real-time source of convective and turbulence information. However, pilots identified its well-known limitations:
  - Attenuation. Uplinked radar composite graphics were frequently cited as supplemental information to help mitigate this limitation.
  - Range (as little as 80nm). Similarly, radar composite graphics help.
  - Interpretation “consistently and confidently” of the display.
  - Better training on use during specific situations.

Pilot Responses

- Turbulence—convective-induced and clear-air—is the most operationally significant weather hazard for pilots and operators for both safety and cost concerns. It is also the most frequently occurring hazard and the most difficult to predict. It is dynamic to the point of even challenging the usefulness of real-time pilot reports. Most of the time, turbulence is operationally handled through mitigation—alerting crew and passengers, and/or altitude changes. Other than turbulence associated with thunderstorms, it is difficult to pinpoint and horizontally avoid.
  - Nearly 90% of the respondents would like to see continued development and dissemination of a product that merges real-time turbulence data with model-based forecasts with frequent updates (every 30 minutes).

Pilot Responses

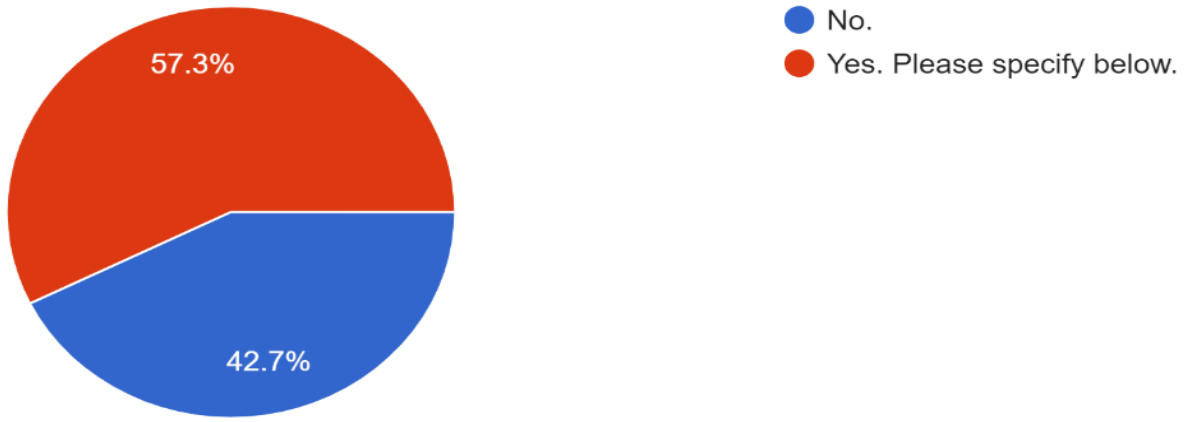
- The problem: Confusion, conflict, consistency issues when pilots are presented with disparate weather information from different sources
  - Nearly 60% of the pilots said that this is an issue. However, 35% say it negatively impacts decision-making.
  - Several pilots credit effective training and experience for mitigating problems associated with conflicting weather information from different sources:

"Newer pilots need to be educated about these topics. Current training in this area is not consistent and depends upon the initiative of the crewmember to self-educate."

Consistency of Weather Information?

Are you aware of any inconsistencies between different sources of similar cockpit weather information (e.g. onboard weather radar versus EFB)?

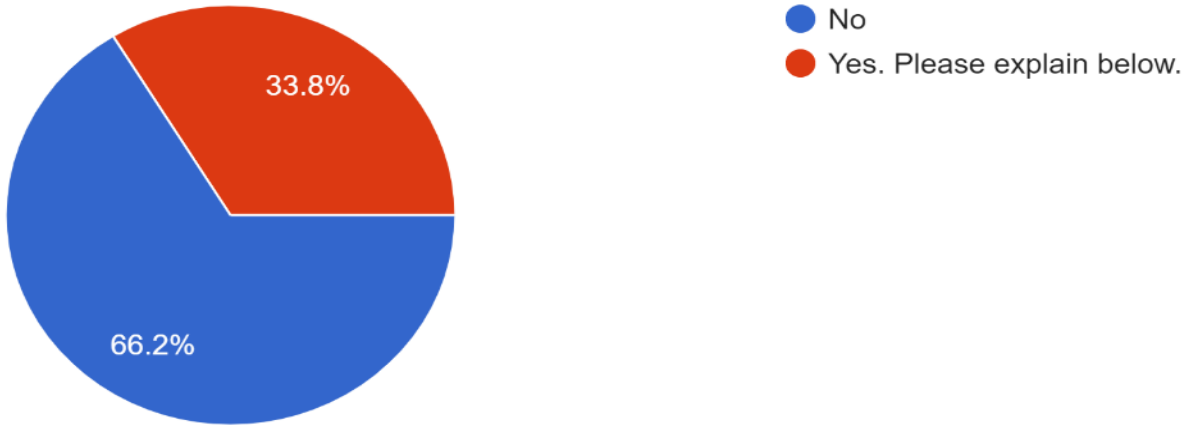
157 responses



Consistency of Weather Information. Problem?

Have these inconsistencies created weather situation awareness confusion? If "yes," please explain below.

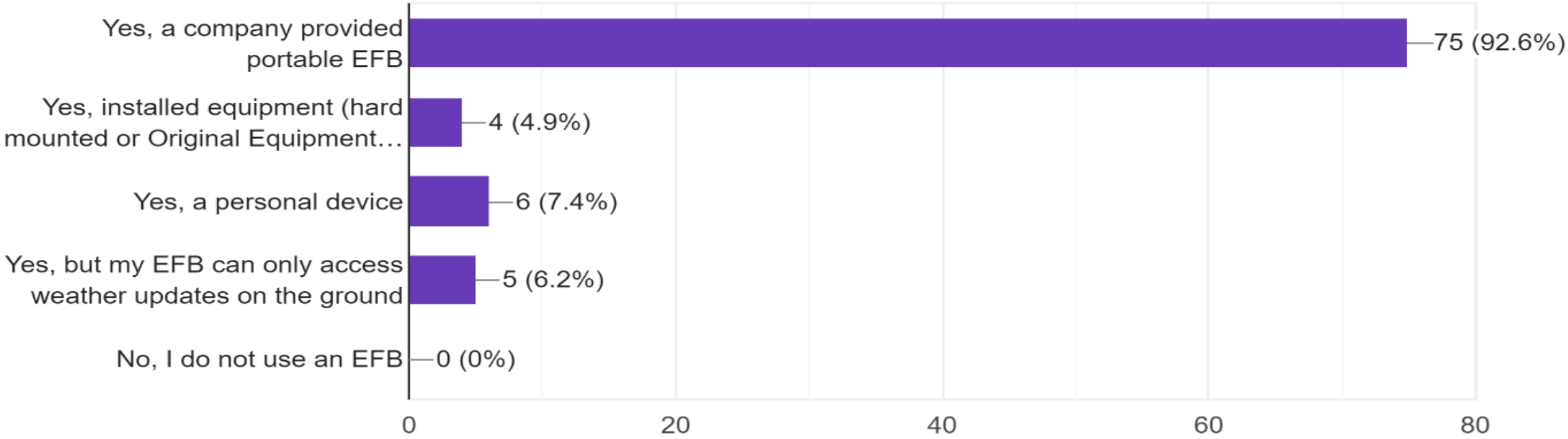
157 responses



Of Those with Internet on the Flight Deck…

Do you use an Electronic Flight Bag (EFB) that can connect to the Internet for inflight weather updates? Please select all that apply.

81 responses



Legacy Source “Fall-back”