Weather Technology In the Cockpit (WTIC) Research and Initial Findings

FAA Center of Excellence for General Aviation (PEGASAS)

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FAA Center of Excellence for General Aviation (PEGASAS)

Partnership to
Enhance
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Safety,
Accessibility and
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PEGASAS Project #4: Weather Technology in the Cockpit (WTIC)

Mission: To perform research towards finding answers to the following questions:

1. Why has the weather related accident rate for General Aviation not decreased more in spite of commercial advances in MET cockpit technology and information?

2. What is the desired minimum weather service capabilities for General Aviation? Are there additional services required for specific segments of General Aviation (e.g. Alaska)?

PEGASAS Project #4: Weather Technology in the Cockpit (WTIC)

Mission: To perform research towards finding answers to the following questions:

3. What is the price point for aircraft equipage and associated recurring fees to receive and utilize a minimum service?

4. What are the shortfalls in pilot understanding and proper use of the information, and what are the pilot training needs to meet these shortfalls?

Project A Quantify Causality

- Expand accident/incident causal research to identify & assess gaps with cockpit MET information
- Determine weather elements, locations, training, and aircraft equipage associated with recently reported GA weather related accidents/incidents
- Identify issues and link them to events (accidents/incidents)

Project B Transition from VFR to IMC

- Address unexpected transition from VFR to IMC, determine WTIC causal factors
- Analyze MET information, procedures, and relevant training used by GA pilots to assess risk of encountering IMC conditions during VFR flight.
- Identify gaps in current minimal weather service & training that may contribute to unintended IMC encounters (poor forecasting, over forecasting, lack of information)

Project C General Aviation Weather Alerting

- Assess feasibility of agile, low latency cockpit weather alerts to identify hazardous weather with minimal pilot analysis.
- Find beneficial use cases for real-time weather alerts by identifying high priority scenarios.
- Perform trade studies on alert implementations and design/develop a prototype.

Project D General Aviation MET Information Optimization

- Evaluate utility of selected MET products as a decision support tool in high stress scenarios.
- Use currently available high workload MET products and evaluate workload, comprehension, time to assimilate information for supporting decision making relative to adverse weather.
- Strive for better presentation of alerts and data.

Project A: Quantifying Causality

Goal: To answer the question:

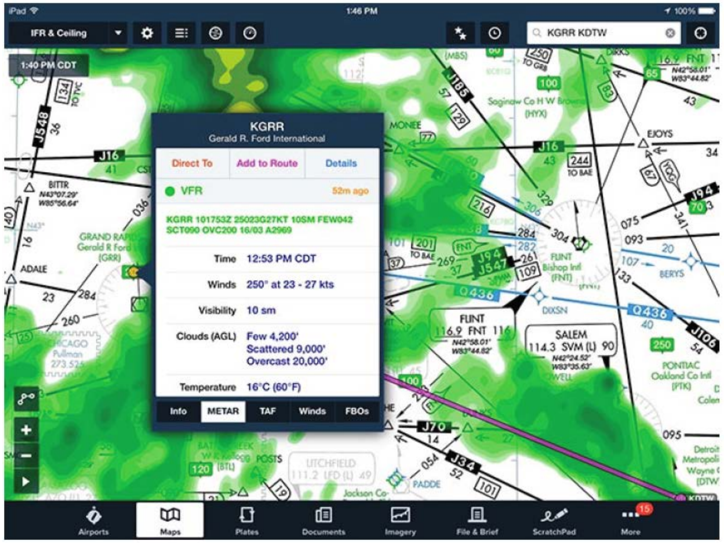
Why has the weather related accident rate for the GA segment not decreased more in spite of commercial advances in MET cockpit technology and information?

And to obtain more insight into causes and locations of GA accidents and incidents

Project A: Quantifying Causality

Task 1: Inventory Variety of MET Products and Services

Primary Finding: Tremendous Variety, and little standardization



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KENT STATE UNIVERSITY

Project A: Quantifying Causality

Task 2: Analyze Weather Related Accidents & Incidents - Findings

2008-2013 ASRS & NTSB data inventoried.

- Approx. 100 FAR Part 91 accidents/incidents per year where weather was a direct factor
- Vast Majority of weather related incidents occur enroute or approach to landing.

Project A: Quantifying Causality

Task 2: Analyze Weather Related Accidents & Incidents - Findings

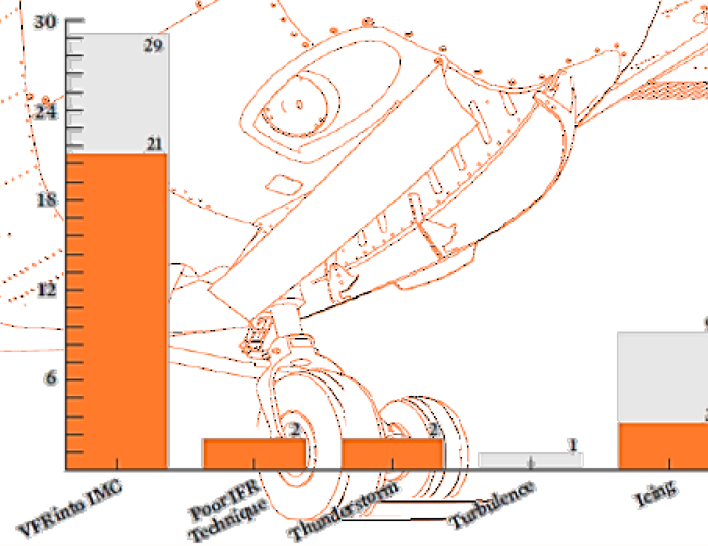
Top causal factors:

- Wind Shear
- Convective Activity
- VFR into IMC

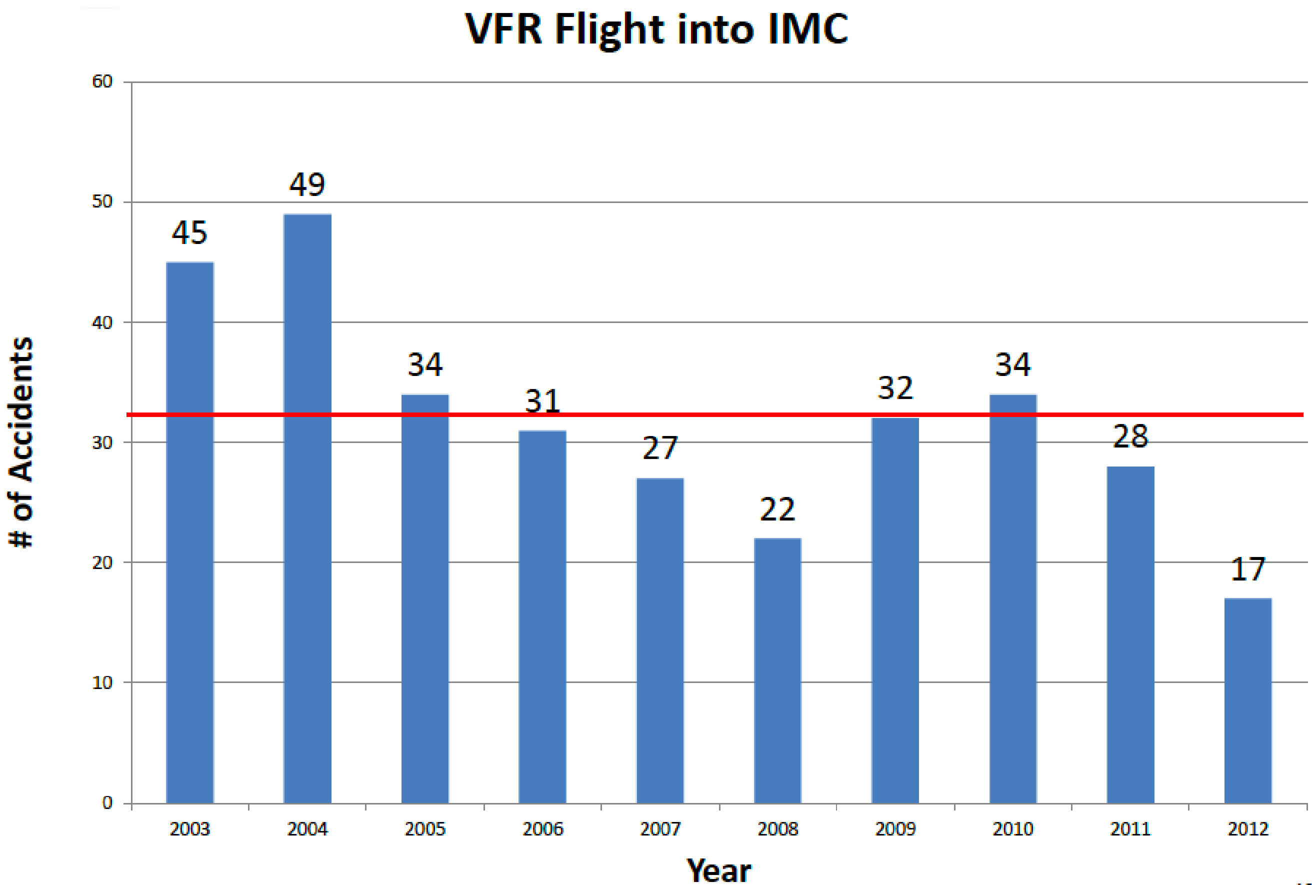
75% "Decision Based Errors" vs. 25% "Skill Based Errors"

Project B: Transition from VFR into IMC

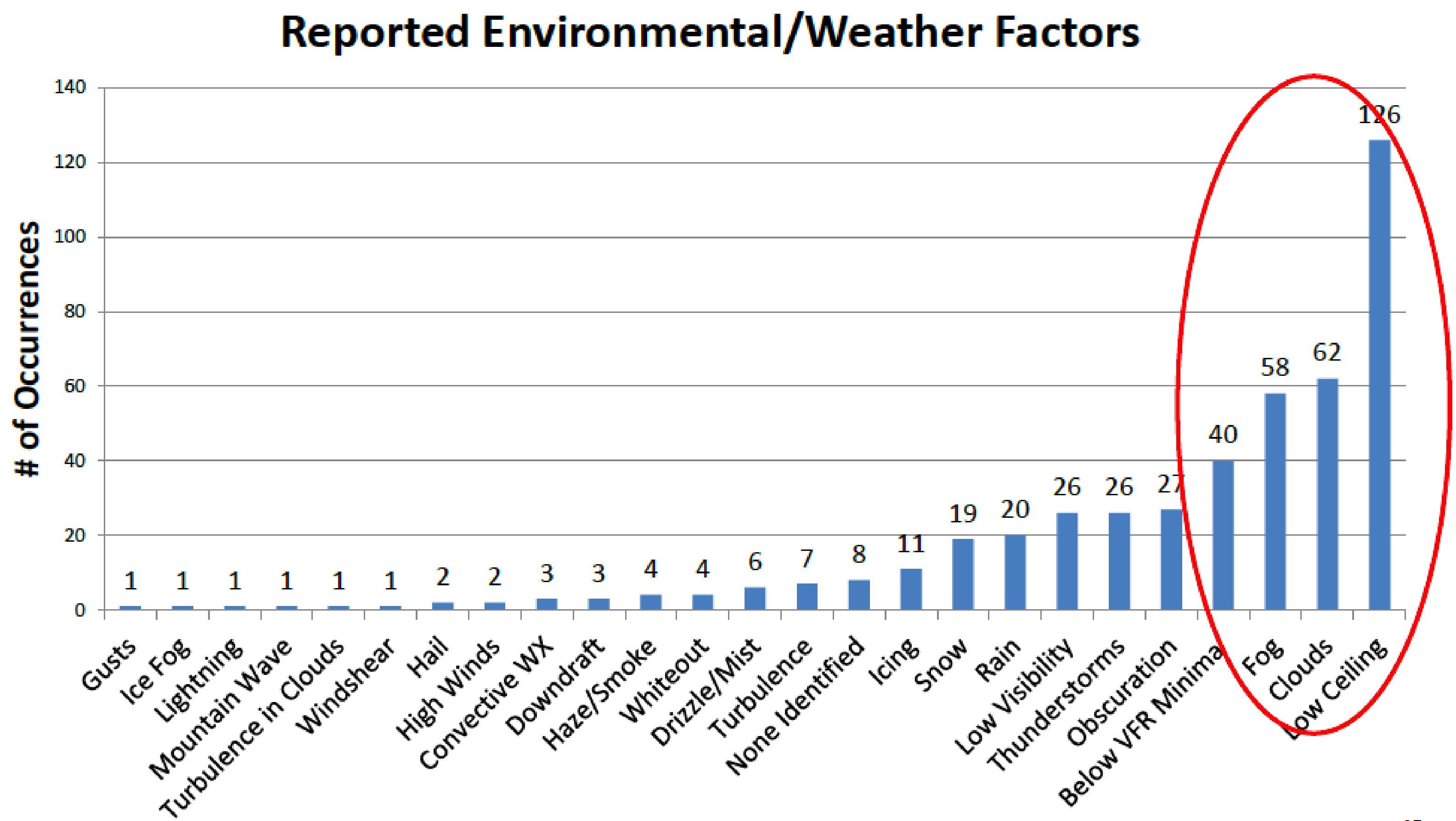
- From the 22nd Joseph T. Nall report:
  - 43 weather-related accidents in 2010
    - 67.4% continued VFR into IMC
    - 72.4 % VFR to IMC resulted in fatalities



Project B: Transition from VFR into IMC



Project B: Transition from VFR into IMC



Project B: Transition from VFR into IMC

- Conducting Survey of pilots to determine their use of in-cockpit MET information regarding decisions on VFR flights.

Goal: To develop training materials that increase VFR-IMC awareness using in-cockpit MET information

#	Answer	Enter Survey	End Survey
1	Student	0	0
2	Sport	1	0
3	Recreational	0	0
4	Private	17	0
5	Commercial	18	0
6	Airline Transport	9	0
7	Flight Instructor Certificate	19	0
8	Ground Instructor Certificate	11	0
9	Instrument Rating	22	0
10	Multi-engine Rating	19	0
11	Single/Multi-engine Sea	4	0
12	Single/Multi-engine Land	15	0
13	One or more aircraft type ratings	4	0
14	Other	4	0
	Total	143	0

Project C: General Aviation Weather Alerting

Goals:

1. Evaluate ability of ***low latency*** cockpit weather alerts to identify hazardous weather.
2. Find beneficial use cases for real-time weather alerts by ***identifying high priority scenarios***.
3. ***Perform trade studies on alert implementations*** and design/develop a candidate alert.

Project C: General Aviation Weather Alerting

- TAMU Engineering Flight Simulator
  - Reconfigurable cockpit
  - Digital or analog instrumentation

- 3 flight scenarios
  - 2 weather events in each

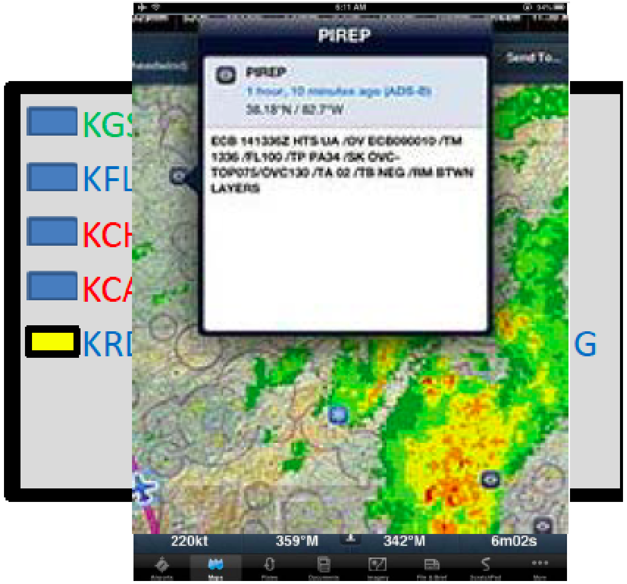
- 4 alert types

- Low and high latency in alerts

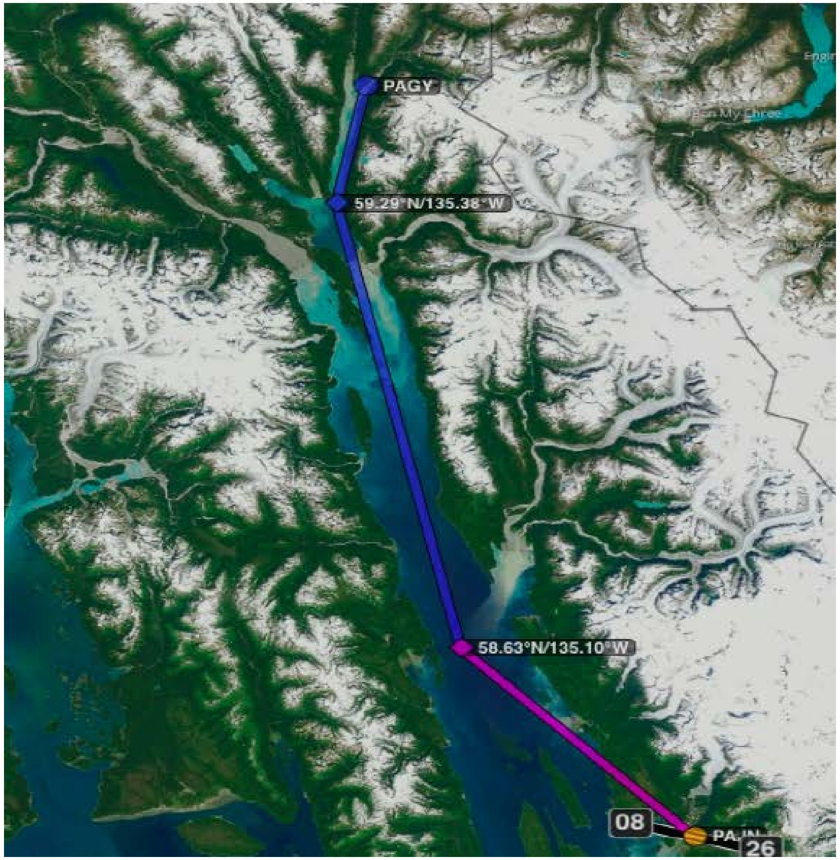
Project C: General Aviation Weather Alerting

Lit review identified key dimensions for investigation (final decisions pending pilot testing)

- Graphical vs. simple textual-based
  - Textual-based with additional encoding (e.g., symbology, color-coding)
- Information access
  - Call for more info
  - Available via selectable menu
  - Immediately displayed
- Attention-directing qualities
  - Visual indication
  - Auditory cue
- Alerts issued with low or high latency
  - low: immediate "textual and symbology message"
  - high: graphical data ~10 minutes old when arrives



Project C: General Aviation Weather Alerting



Juneau, Alaska (PAGN) to Skagway. (PAGY)

- This Alaska scenario highlights the unique aspects of flying in that region with respect to its
- weather, terrain, infrastructure (FAA aviation cameras).
- Few alternates available. Near sea level runway situated in a narrow valley.
- Steep mountains are located on either side of the departure path, which places the airplane in an increasingly narrowing canyon.

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Project C: General Aviation Weather Alerting

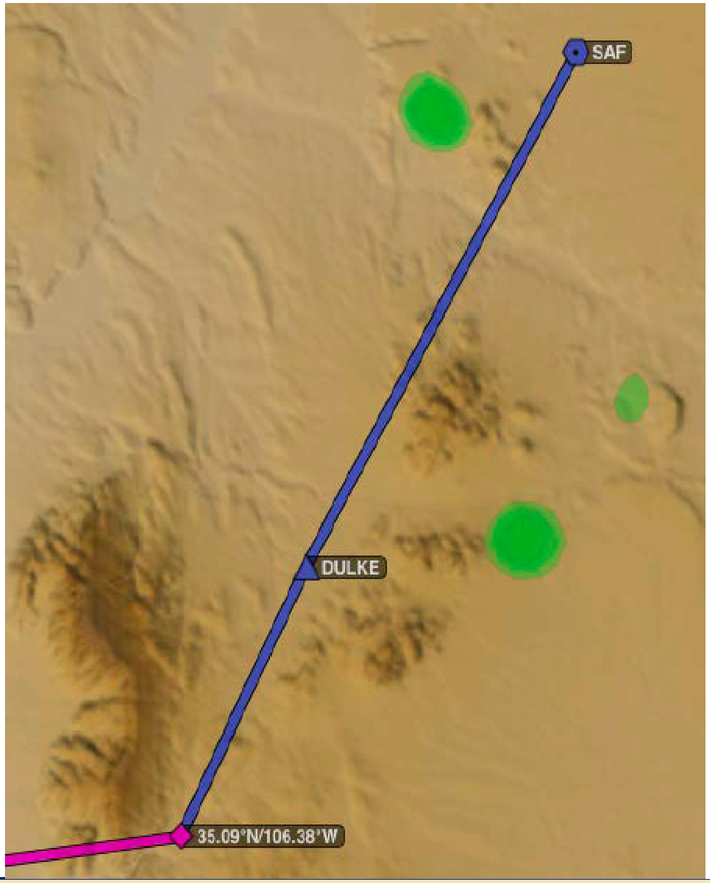
Scenarios

Warren Field (KOSW), Cape Fear (KSUT), North Carolina.

The flight includes two possible weather encounters convection, IMC).

- The (NEXRAD) weather display in the cockpit will be 7-15 minutes older than the actual conditions, with attenuation from a squall line with embedded hail. If the pilot uses the radar to navigate the thunderstorms they may encounter severe turbulence and hail.
- The area southwest of the Cape Fear runway threshold has been described as a "black hole" at night due to the lack of ground lighting.

Project C: General Aviation Weather Alerting



The route from Santa, Fe (KSAF) to Albuquerque, NM (KABQ).

- Consists of gradually rising terrain during the first two-thirds of the flight, followed by a dramatic elevation change during the last third.
- The flight includes two possible weather encounters, Mountain wave turbulence and mountain obscuration.

Project C: General Aviation Weather Alerting

Findings to Date:

Review of recent research, accidents and incidents, suggests the following could contribute to a potential gap in the effective use of cockpit weather information to decrease safety risk and increase situational awareness:

1. Lack of formal training for new technology use
   - No formal logbook endorsement/checkout required when transitioning to highly advanced avionics (similar to other logbook endorsements FAR 61.31(a), 61.31 (g) FAR 61.31
2. A need to 'call attention to' and increase understanding of potential alerts; (e.g., AIRMET)
3. Lack of understanding of actions necessary to obtain information through other sources, when failures occur with technology

Project C: General Aviation Weather Alerting

Findings to Date:

4. Understanding of Data Integrity/Limitations of use
5. Overload of Information
6. Over-reliance
7. Decision Making associated with the displayed information
8. Personal minimums related to the displayed information
9. Temptation to accept more risk with more information/automation
10. Need to confirm information with visual conditions and other information when appropriate
11. Strategic vs. Tactical use of information
12. Recognizing/prioritizing conflicting information

Project D: MET Information Optimization

- Critical Task: ***Obtain an Updated Weather Information Brief*** using selected systems
- Consideration of ***Available*** Systems as of Dec 31, '13
  - Approx. 10 fixed and mobile aircraft-specific hardware systems with FMS / glass cockpit integration
  - Over 50 software systems (iOS, Android) on tablets or smartphones
  - Comparisons to ***Approved*** Briefings:
    - www.aviationweather.gov (via NOAA NWS)
    - 800-WX-BRIEF (via telephone, pilot manual recording)
- Challenge of New WX Systems vs. WMO METAR
  - Coded text format dates to 1968, variant 1989

Project D: MET Information Optimization

Pugh Matrix Detail: Criteria x System

Criteria	*Importance Rating*	Product / Tool Alternatives: 1-800-WX-BRIEF	ForeFlight (With WiFi to Internet or ADS-B Receiver)	Aviation Weather on Android Tablet	Garmin1000 with XM Weather	Avidyne R9 w/ MX 770	Aviationweather.gov	eWx on Android Tablet*
Approval Status		S	S	_			S	_
Source of Information		S	S	S	S	S	S	_
Type of Information		S	+	+	+	+	+	_
Affordability		S	_	S	_	_	+	+
Portability		S	_	+	_	_	+	+
Review Classification		S	+	+	+	+	+	S
Platform		S	+	+	+	+	+	+
Availability		S	+	_	+	+	_	_
Recency		S	+	_	+	+	+	_
Sum of Positives			5	4	5	5	3	3
Sum of Negatives			2	3	2	2	5	5
Sum of Sames			2	2	1	1	1	1

Product/Tool Selection Legend

Better	+
Same	S
Worse	-

Investigating “quality” of products from pilots perspectives.

7 Products Compared

Project D: MET Information Optimization

- Purported MET System vs Critical MET Information
  - Most popular tools may not have TAF, PIREP, AIRMET, etc.
  - Technology integration (WiFi + Stratus example)
- Unexpected, Important Task and Procedure Distinctions
  - Human Factors of getting information vs. Human-Systems Integration of flight activity logging
  - Distinguishing “obtain weather information” from “obtain ***and log weather briefing***”
- Detailed Task Analyses Regarding Workload, Procedure Following, System Integration
  - Setup and proactive tasks to change / simplify / influence en route pilot workload and task performance
  - Safe practice vs. common practice (flight plans)

PEGASAS WTIC Project D, June 3-5 201

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Questions Welcome.

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