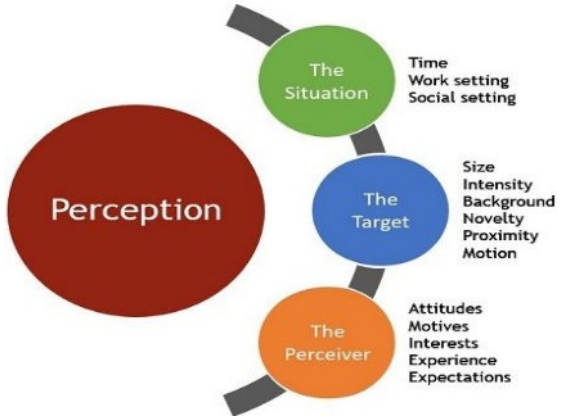
We’re Only Human



Presented to:

Friends and Partners in Aviation Weather

By: *Dr. Meredith Carroll, and Dr. Ian Johnson*

Date*: April 20, 2022*

Trend and Types of Weather-Related Accidents

Figure 1.7.1: Weather accident trend

2019 Non-commercial fixed-wing

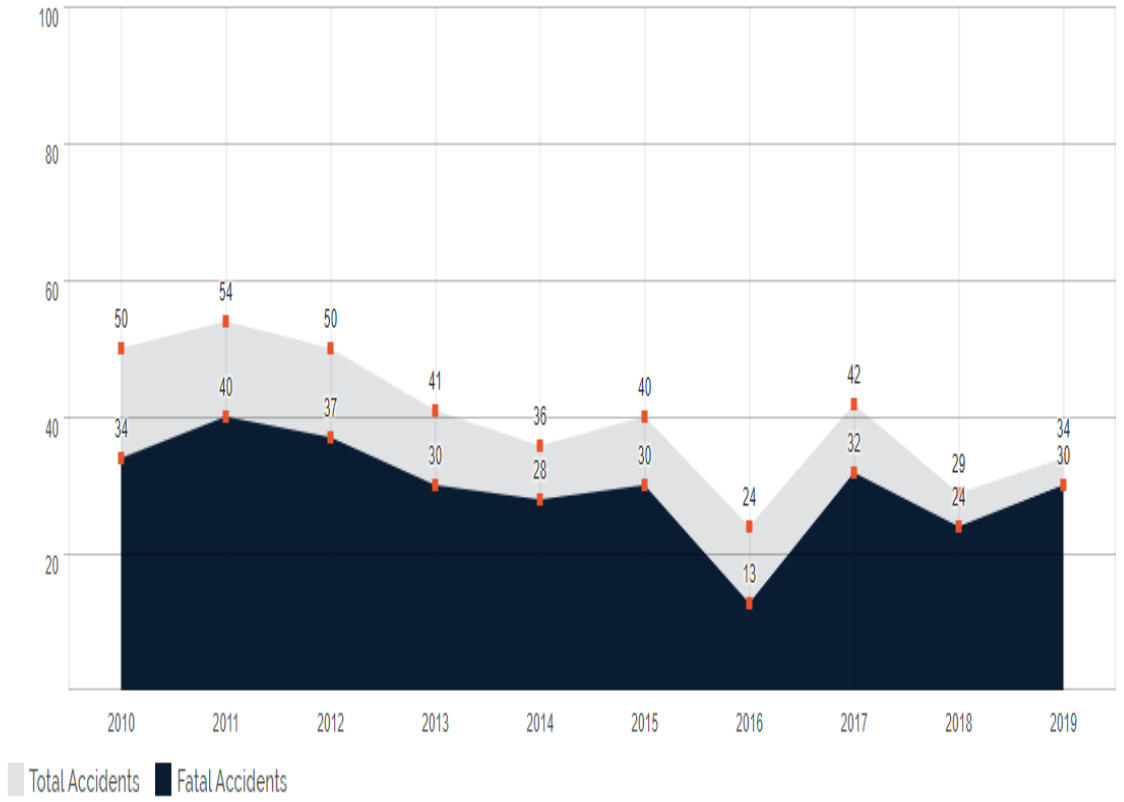
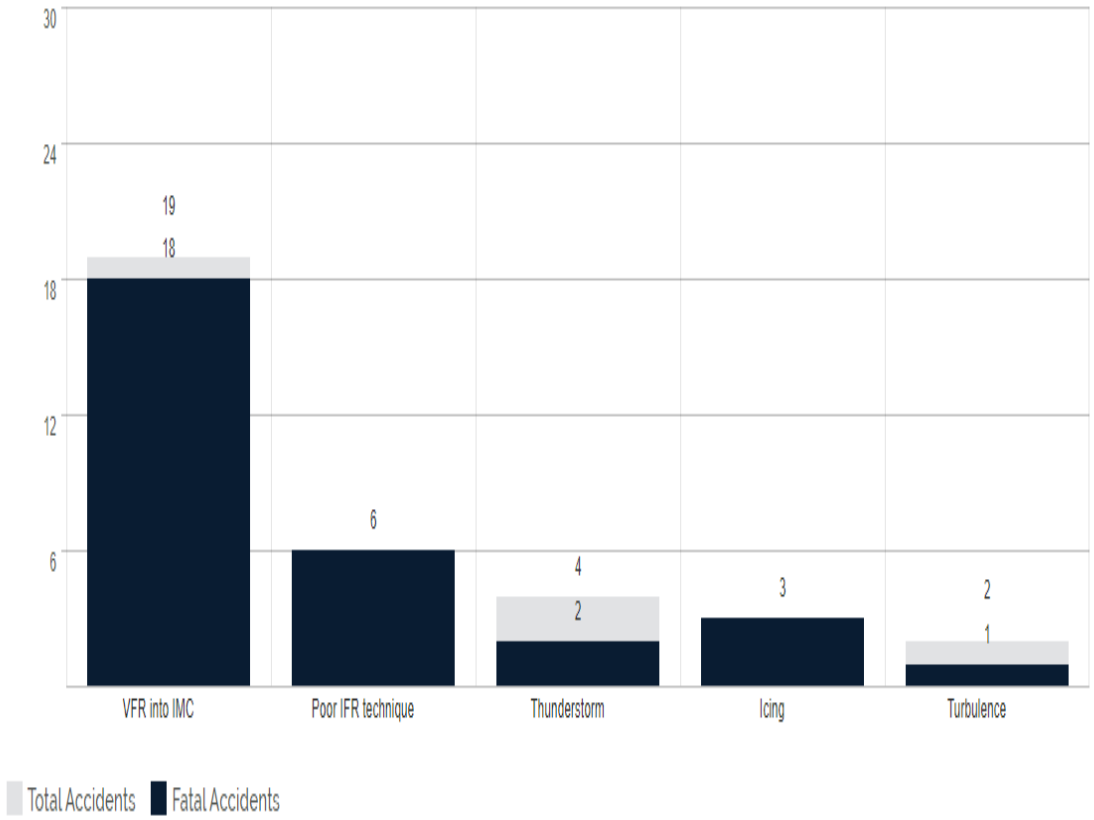


Figure 1.7.2: Types of weather accidents

2019 Non-commercial fixed-wing



Source: 31st Joseph T. Nall Report; General Aviation Accidents

Pilot Certification and/or Rating

Figure 1.7.5: Pilots involved in weather accidents

2019 Non-commercial fixed-wing

	Accidents		Fatal Accidents		Lethality
ATP	2	5.9%	1	3.3%	50%
Commercial	12	35.3%	9	30%	75%
Private	18	52.9%	18	60%	100%
Student	1	2.9%	1	3.3%	100%
Other or unknown	1	2.9%	1	3.3%	100%
Second pilot on board	3	8.8%	3	10%	100%
CFI on board	5	14.7%	3	10%	60%
IFR pilot on board	24	70.6%	20	66.7%	83.3%

"CFI on board' and 'IFR pilot on board' include single-pilot flights.

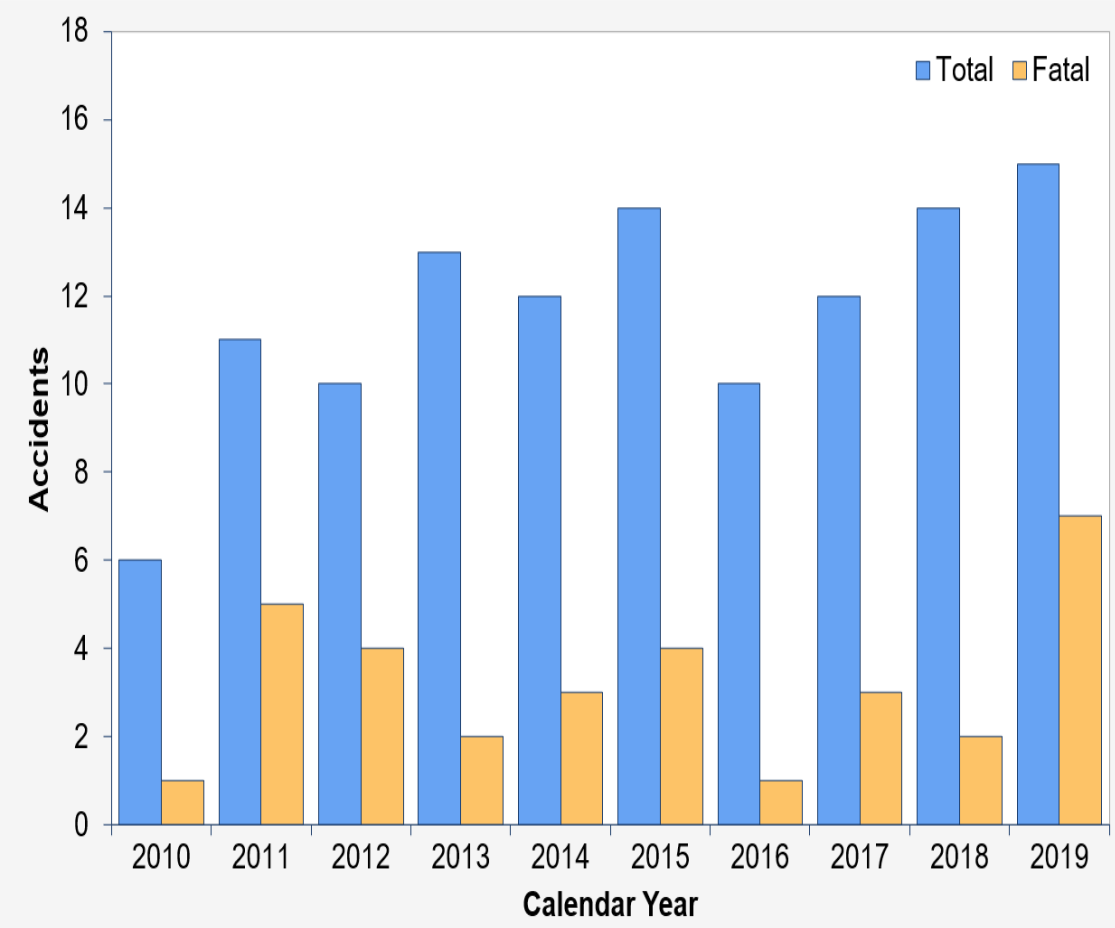
Figure 1.2.1: 'Other' and unclassified accidents

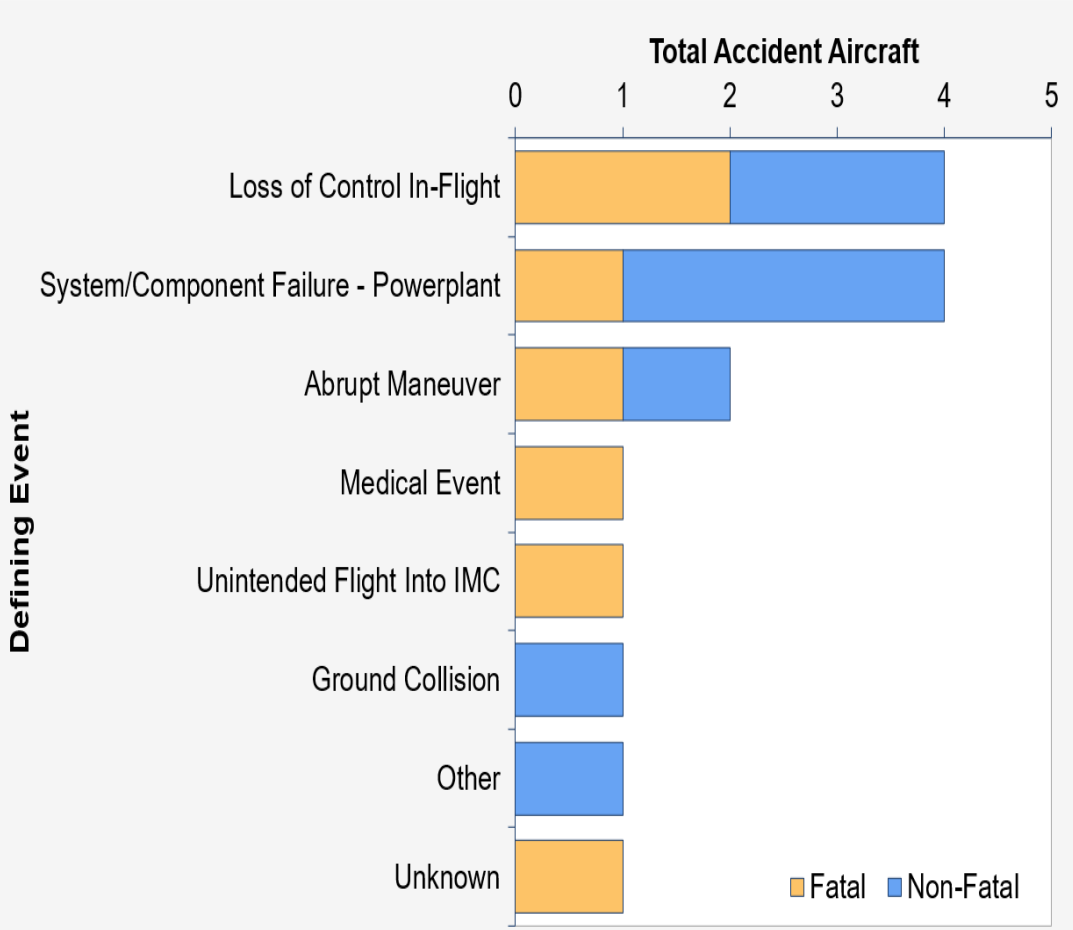
2019 Non-commercial fixed-wing

	Accidents	Fatal Accidents	Lethality
Other	88	52	59.1%
Landing	22	2	9.1%
Other (power loss)	14	1	7.1%
Descent / approach	12	7	58.3%
Take-off	10	1	10%
Weather	8	6	75%
Fuel management	8	0	0%
Maneuvering	7	5	71.4%
Collision	4	1	25%
Pre-flight	3	1	33.3%
Go-around	2	0	0%
Cruise	1	0	0%
Taxi	1	0	0%

Source: 31st Joseph T. Nall Report; General Aviation Accidents

Non-Scheduled Part 135 Helicopter Accidents & Defining Event, 2010-2019





Source: https://www.ntsb.gov/safety/data/Pages/AviationDataStats2019.aspx#NTSB

Contributing Factors to General Aviation Weather-Related Accidents

Research indicates numerous contributing factors to the General Aviation Weather problem.

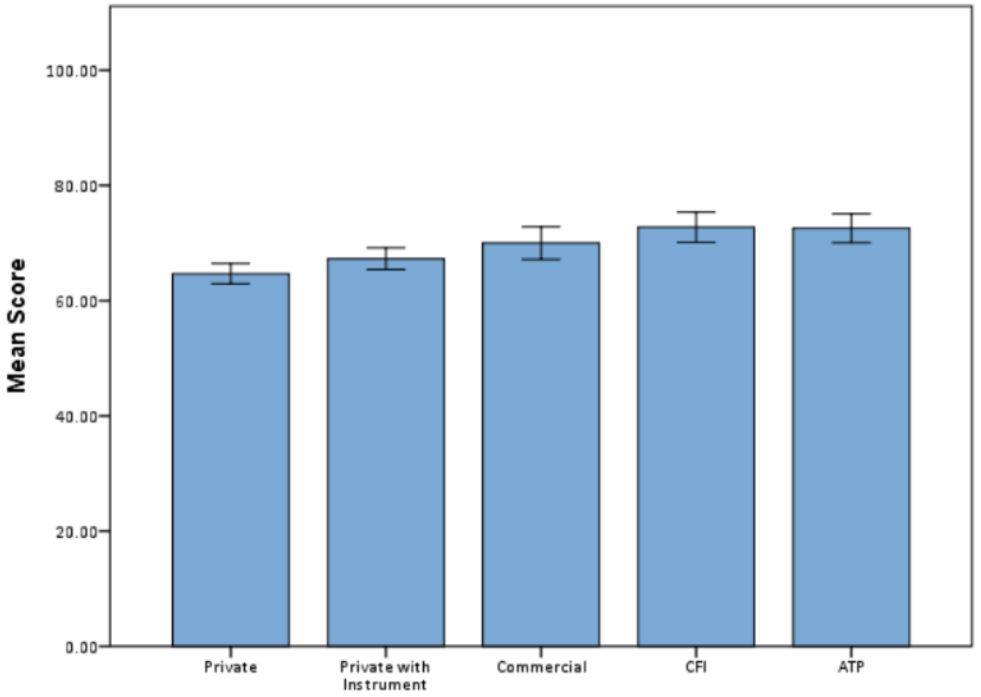
- Lack of Aviation Weather Knowledge & Skills
- Weather Technology & Product Usability
- Conflicting & Out-of-Date Pilot Resources
- Poor Decision-Making
- Limited Weather Training

Source: (Blickensderfer et al., 2019)

Key Issue: Interpretability of Weather Products

"A pilot who does not understand aviation weather products may be at higher risk of encountering hazardous weather." (Blickensderfer et., al., 2019)

- Recent research has found that pilots have difficulty interpreting many aviation weather products (Blickensderfer et al., (2019)



Weather Knowledge Research

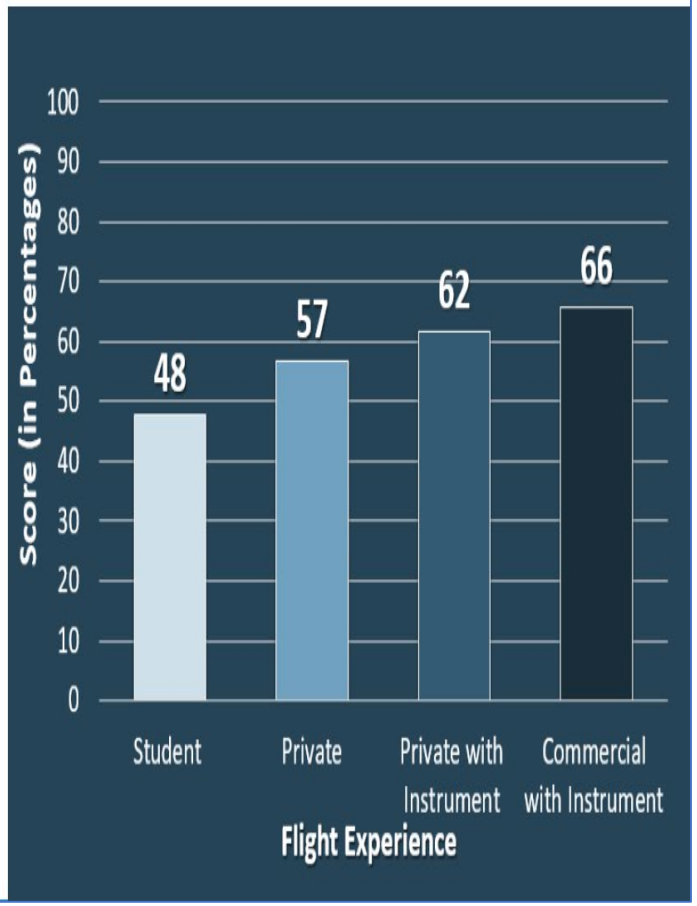
204 Pilots Participated

- Both ERAU Students and GA pilots at EAA Airventure
- Average Age: 22.5 years
- Part 61: 60 pilots & Part 141/142: 143 pilots

Pilot Certificate and/or Rating	Number of Pilots (Total = 204)	Flight Hours (Median)
Student	41	35 hours
Private	72	105 hours
Private with Instrument	50	172 hours
Commercial with Instrument	41	260 hours

Overall GA Weather Knowledge

- Scores increased with flight experience
- Statistically significant differences between
  - student vs private pilot groups
  - private vs commercial with instrument groups
- These trends were consistent

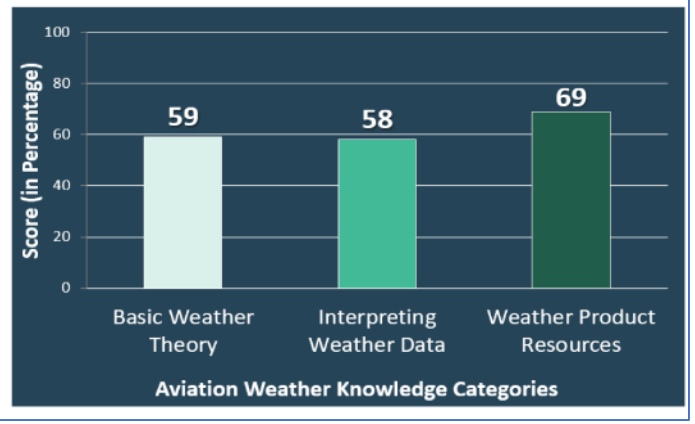


Source: (Blickensderfer et al., 2019)

Weather Knowledge Research

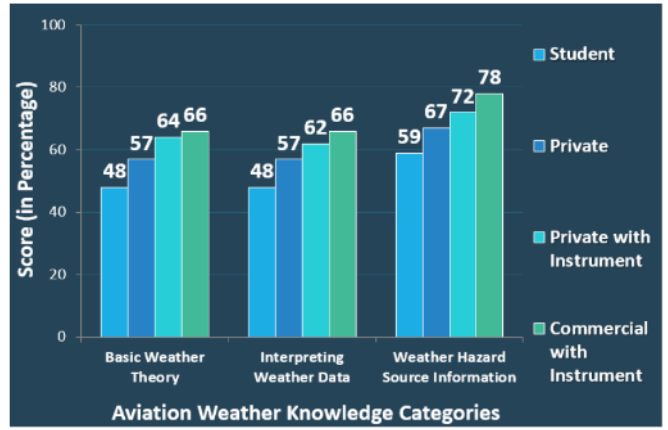
Basic Weather Theory, Product Interpretation, & Weather Product Sources

- Weather product sources was one of the highest scores



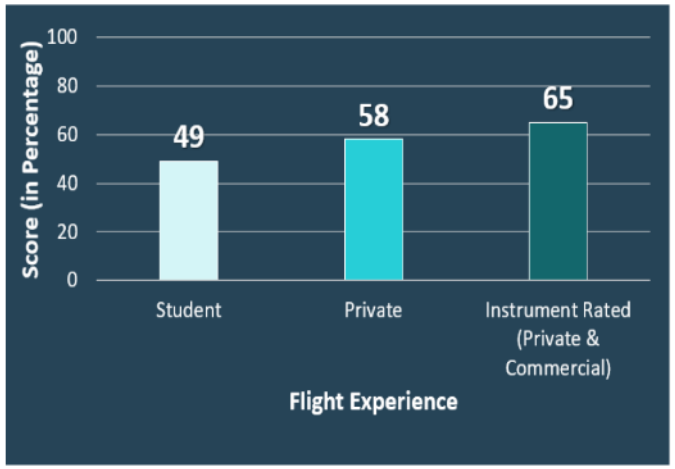
Impact of Flight Experience on Pilots' Aviation Weather Knowledge

- Scores increased with more flight experience



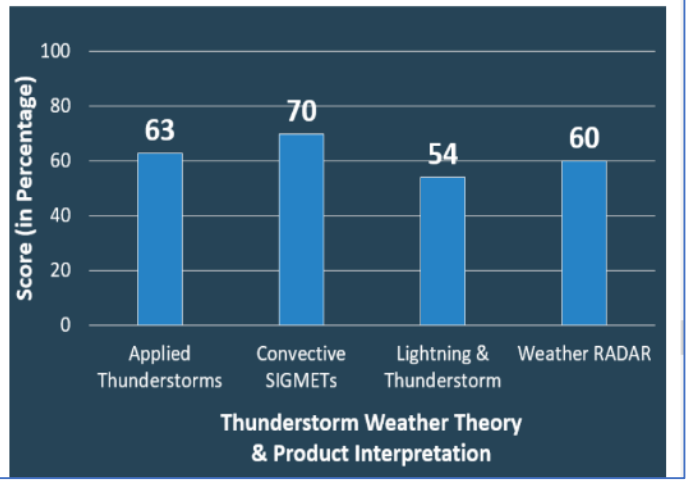
Pilot Performance on IMC and VFR Knowledge and Skills

- This includes Surface Charts, Satellite Data, & PIREPs involving IMC weather



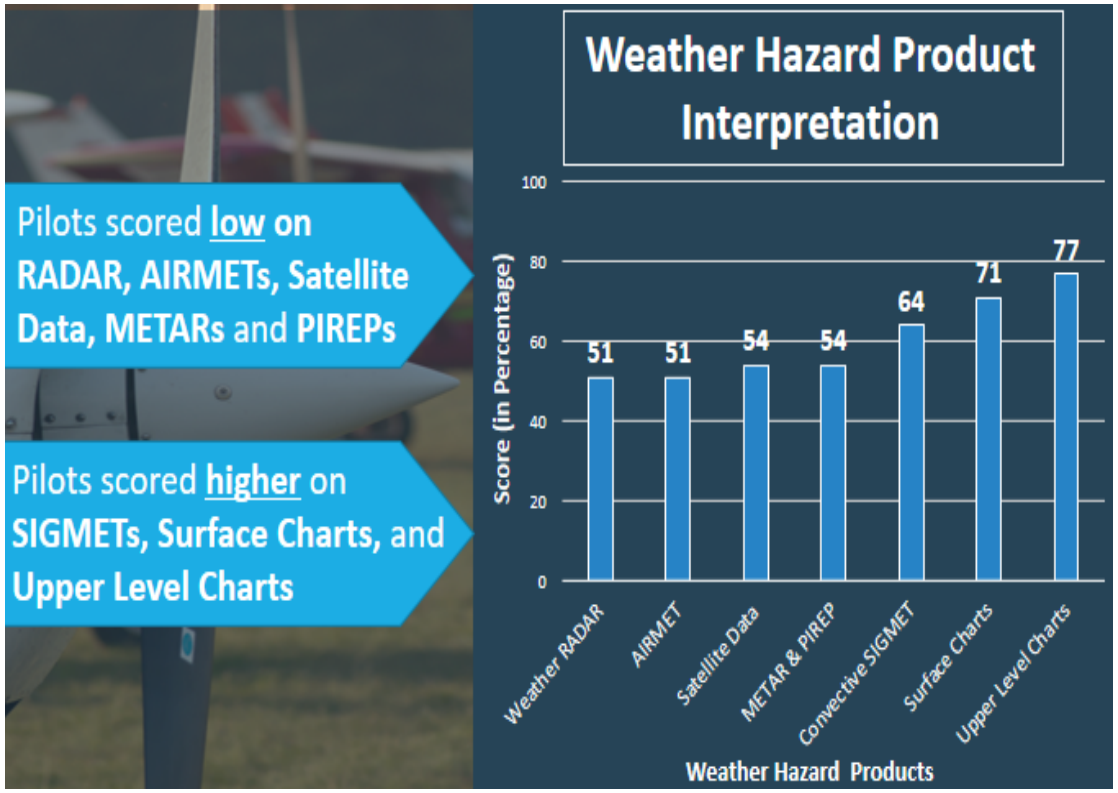
Thunderstorm Knowledge and Skills

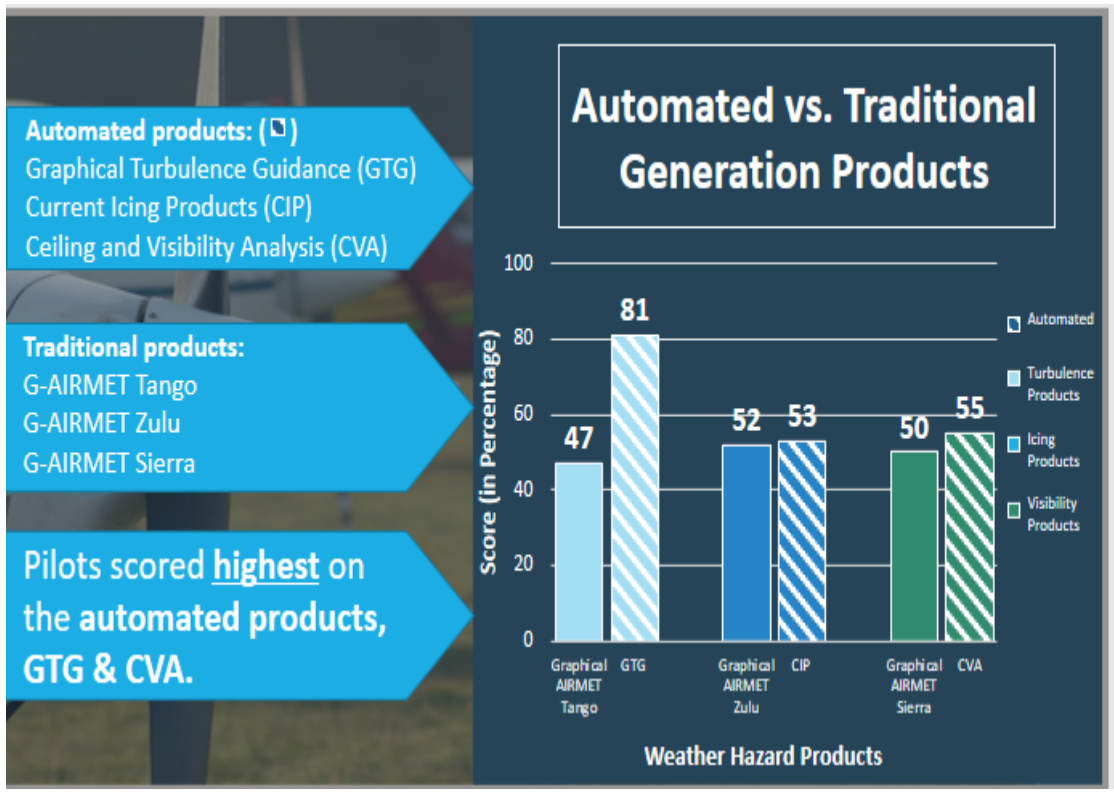
- Pilots scored low on thunderstorm principles and radar interpretation



Source: (Blickensderfer et al., 2019)

Weather Knowledge Research

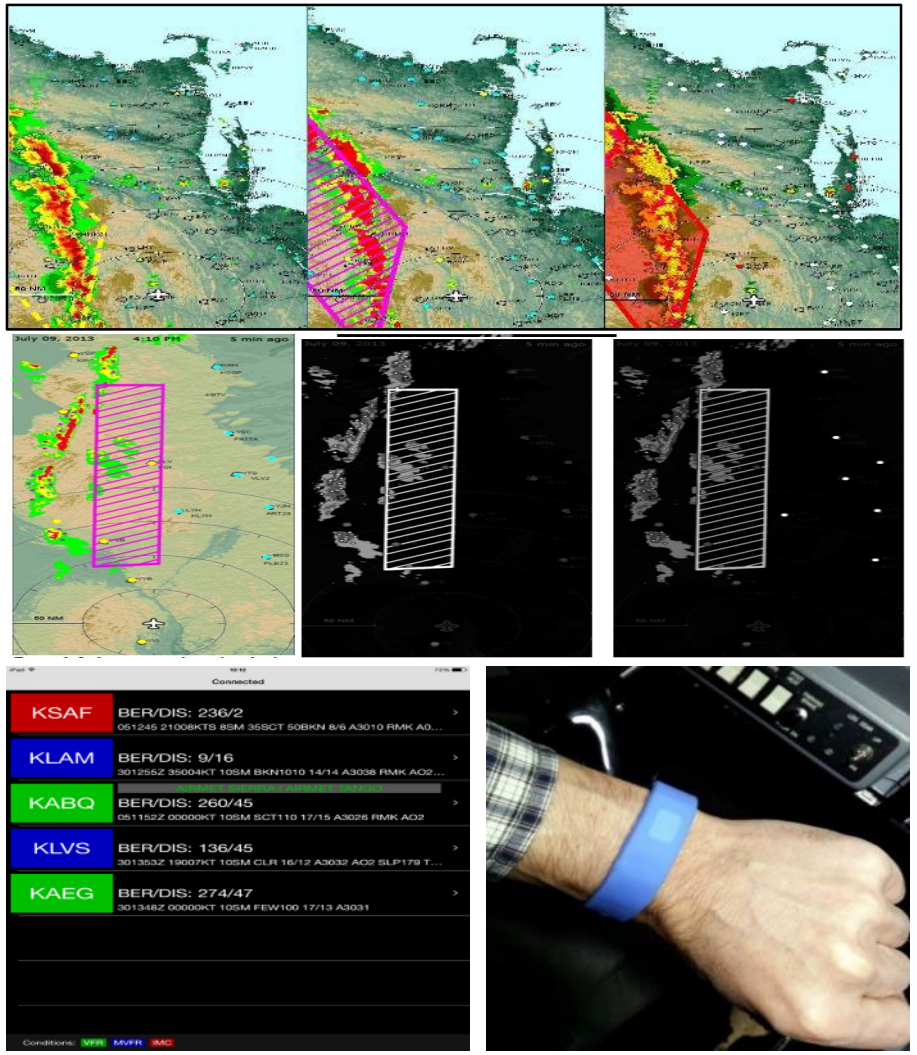




Source: (Blickensderfer et al., 2019)

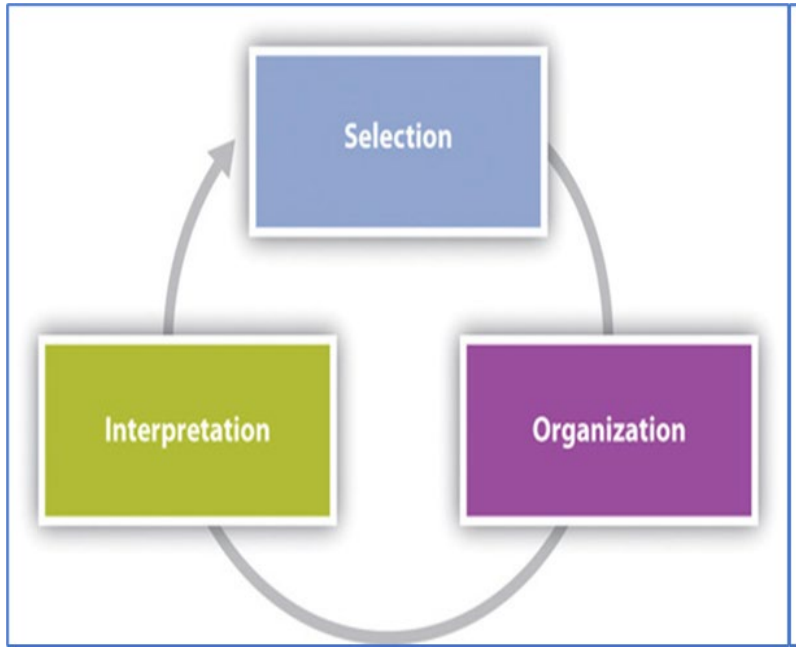
Pilot Perception of Weather: WTIC Research

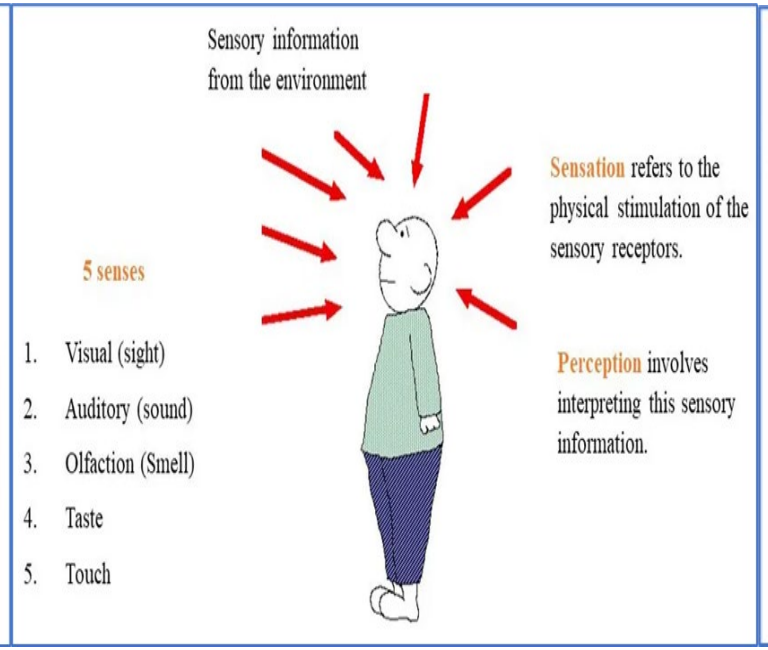
- Assessed GA pilots' perception of changes in METAR symbology and airport visibility conditions
  - Depending on the symbol shape and color, pilots varied considerably in their overall detection of METAR symbol change during flight.
- Assessed symbology salience and its effect on symbology recognition
  - Enhancing display symbols increases the discriminability accuracy and reduces the response time
- Assessed weather notification function to notify GA pilots of state changes in weather
  - Weather state-change notifications (via tactile feedback) improved pilot weather situation awareness and reduced cognitive workload



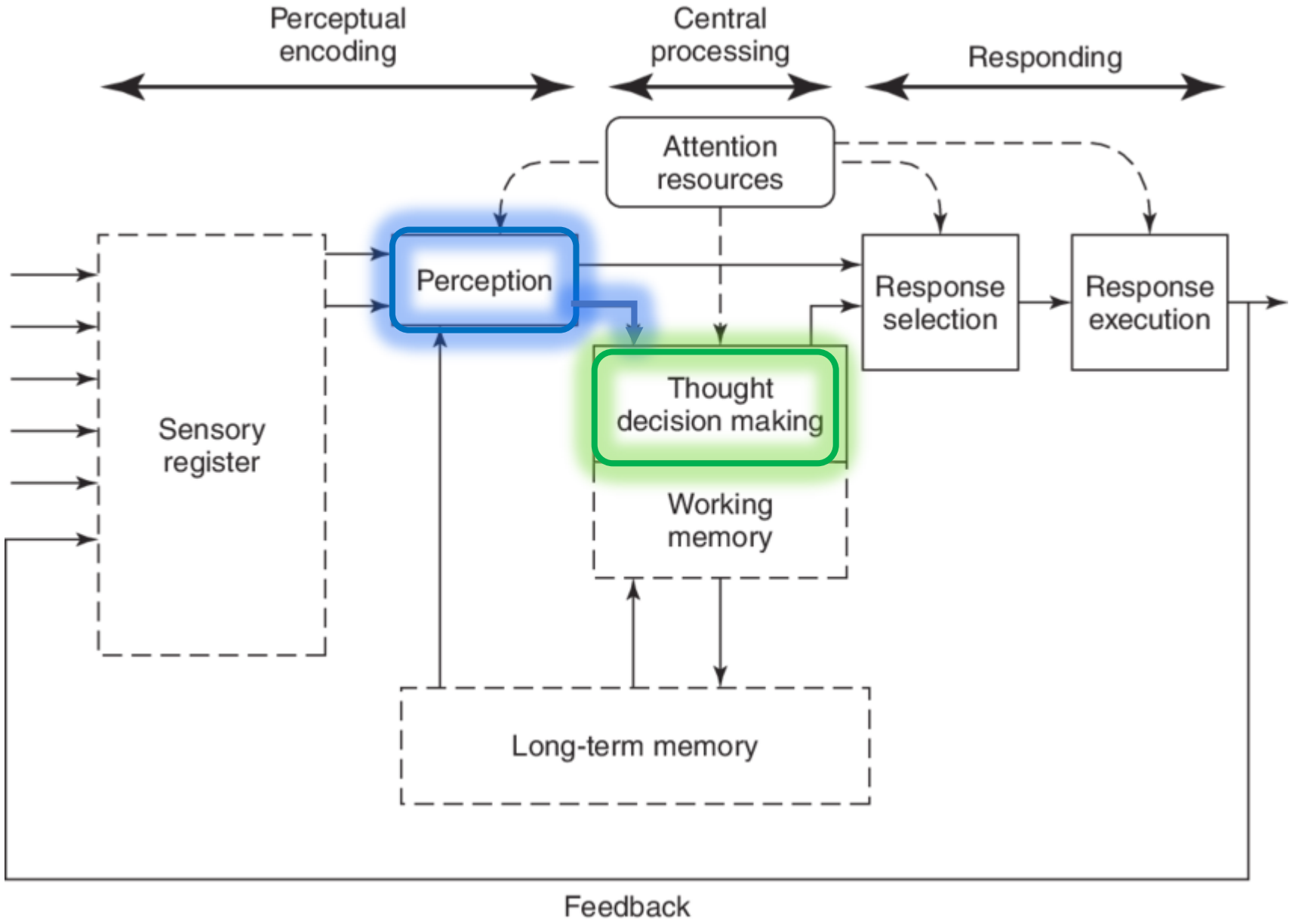
What is Perception, and Why is it Important?

- Perception: process by which individuals **select**, **organize**, and **interpre**t information received through senses.
- This process is important because it helps us to interpret and understand everything around us.
- Human behaviour is based on perception of what reality is, not on reality itself





Perception is a Cornerstone of Decision Making

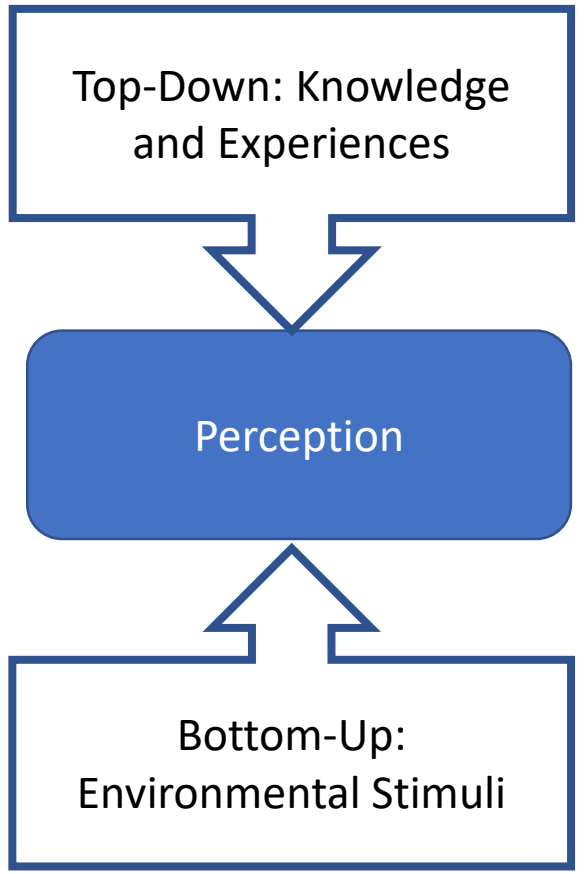


Top-Down and Bottom Up Influences of Perception

Perception is influenced by:

1. Top-down influences derived from knowledge schemas
   - Knowledge
   - Mental Models
   - Past Experiences
   - **Training**

2. Bottom-up influences derived from the environment
   - Environmental Cues
   - Communications
   - **Information displays and products**

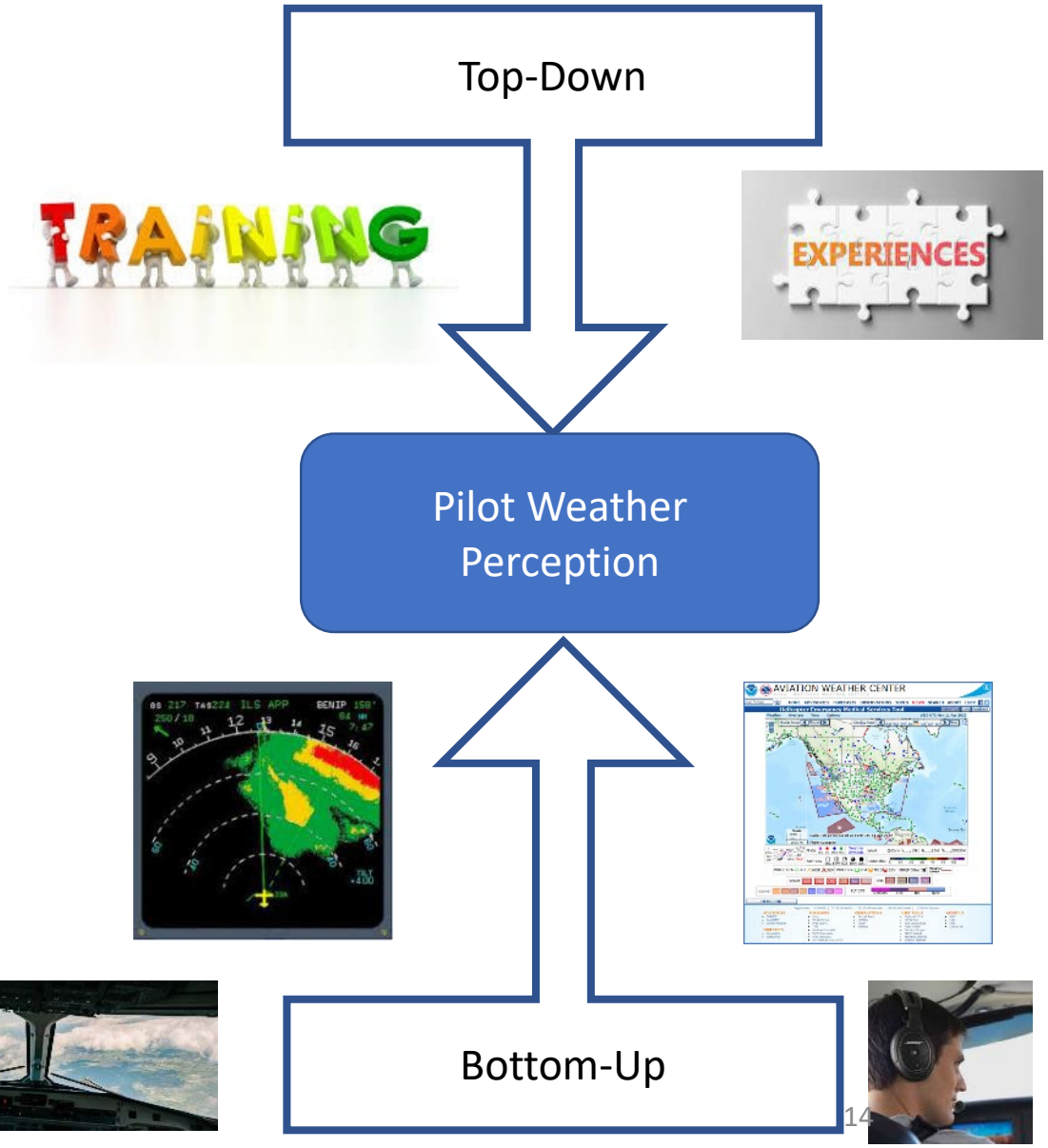


Influences of Pilot Weather Perception

Pilot weather perception is influenced by:

1. Top-down influences
   - Knowledge of how weather phenomena influence flight safety
   - Past Experiences with weather phenomena in flight
   - Mental Models of weather and weather information sources
     - Accuracy, Reliability, Recency
   - **Training**
     - **Weather phenomena impacts on flight**
     - **How to interpret weather information sources**

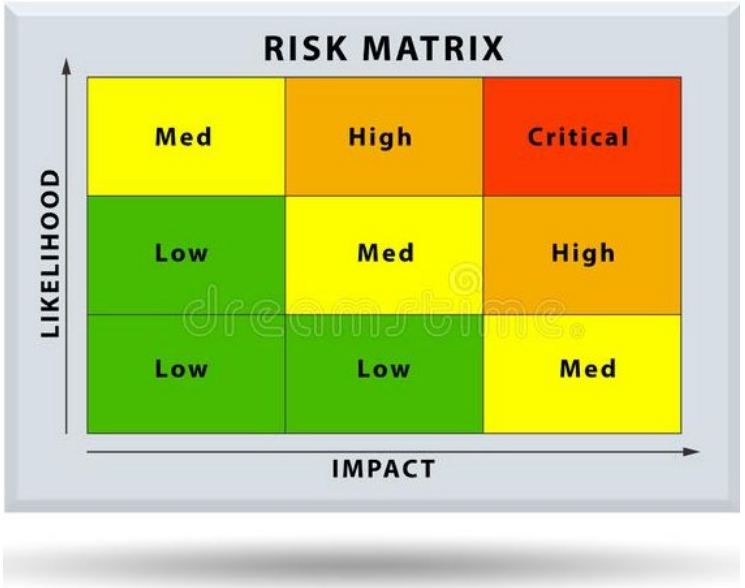
2. Bottom-up influences derived from the environment
   - Environmental Cues
     - Visual out the windscreen
     - Feeling of turbulence
   - Communications with ATC and other pilots
   - **Weather Information sources/products**
     - **NEXRAD**
     - **AIRMET**
     - **SIGMET**
     - **TAFs**
     - **METAR**
     - **PIREP**

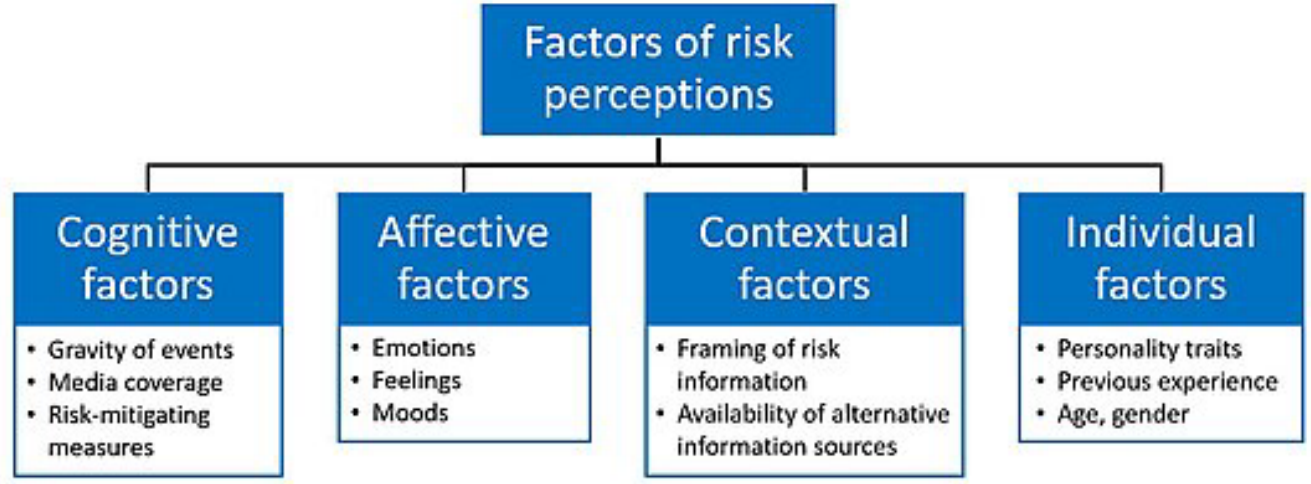


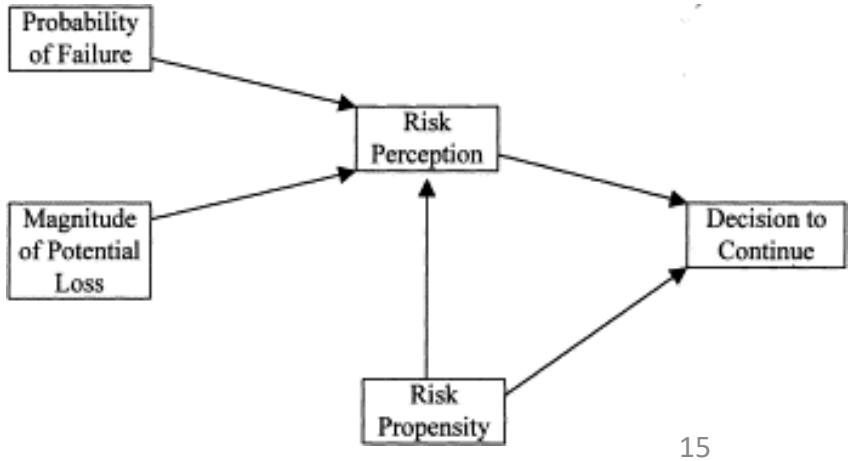
Perception of Weather-related Risk

- Risk: exposure to or potential for danger or injury
  - Severity/Impact
  - Likelihood

- Risky Decisions are Influenced by and Individuals':
  - Risk Perception: an individual's assessment of the likelihood of undesired consequences
  - Risk Propensity: an individuals' willingness to take risk

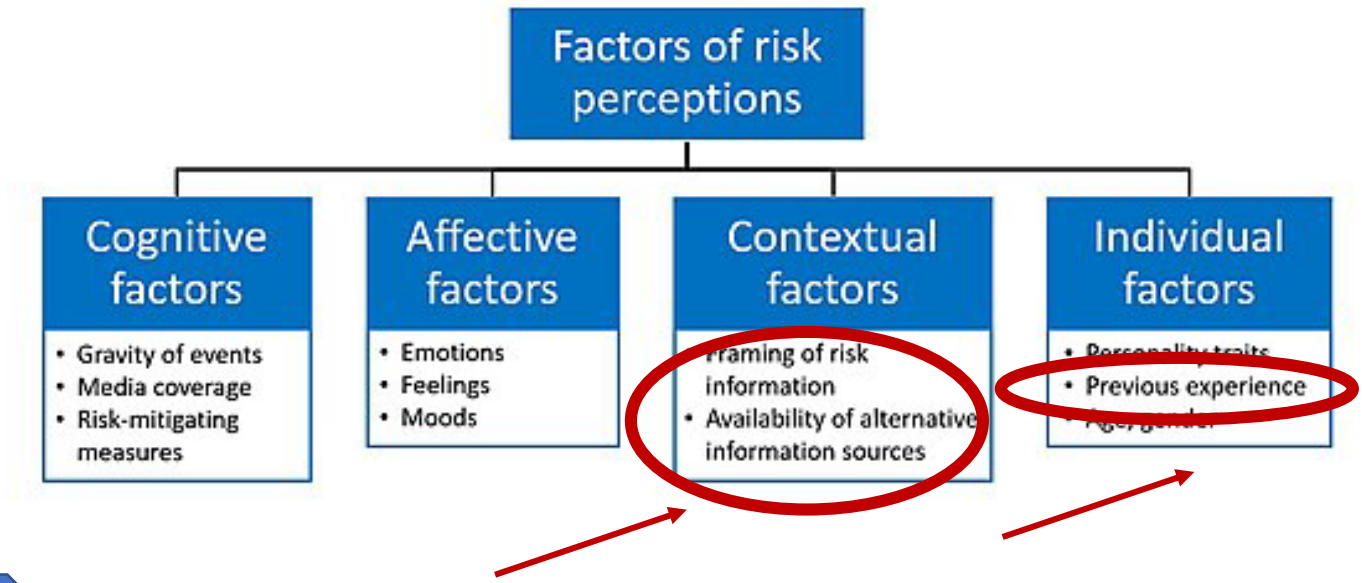






Mitigating Risk in Risky Decision

- Risk Mitigation: process of reducing risk exposure and minimizing the likelihood of an incident.
  - Policy and Procedures
  - Training
  - Information Systems



We can influence risk perception and risky decisions through:

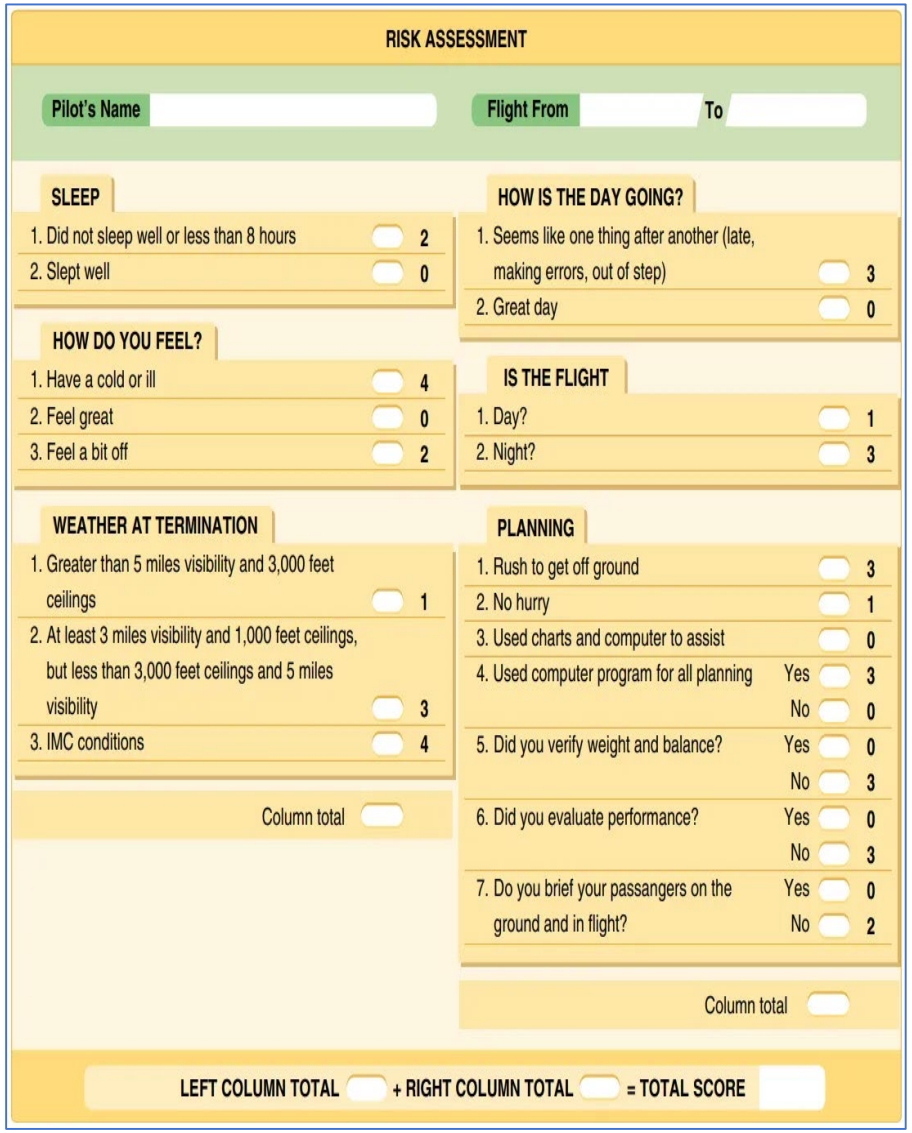
Information Source Design
- Weather information sources and products

Training
- Related to weather products and how to utilize these products effectively in different situations

Risk Identifying, Assessing and Mitigating Tools

Mitigating the Risk

- Wait until the weather is VFR
- Take an IFR current & IFR proficient pilot
- Cancel the flight
- Consider driving

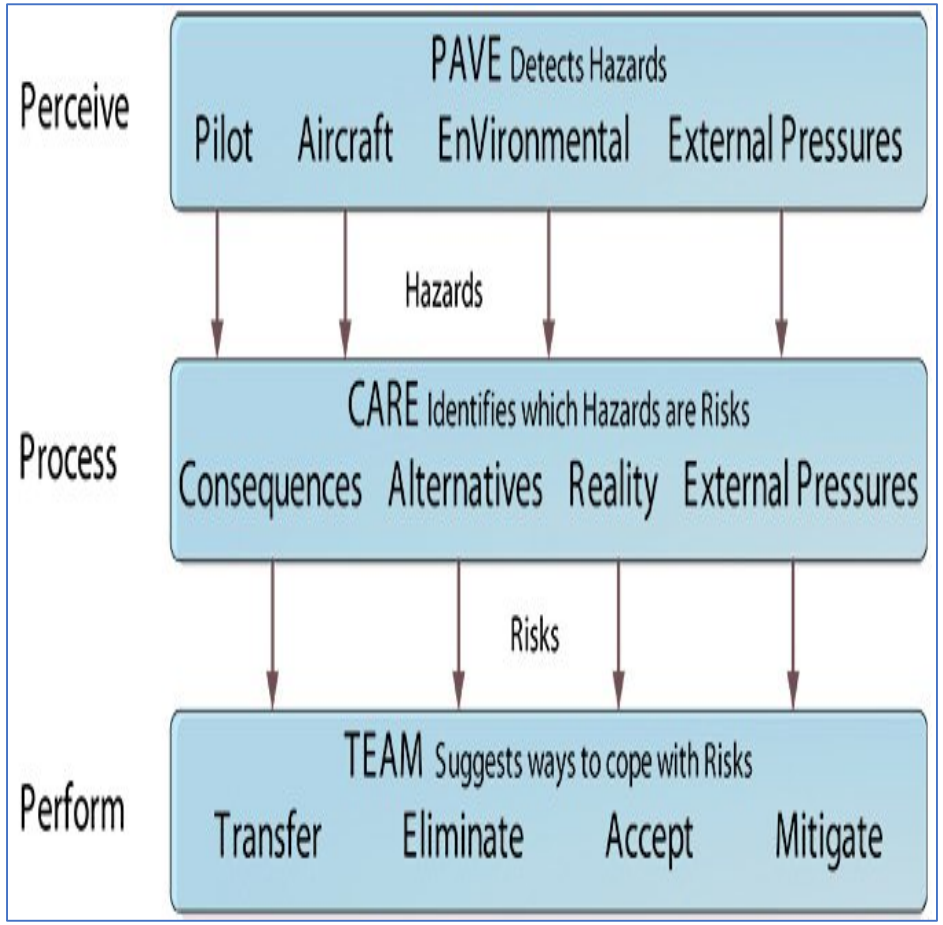


Source: Risk Management Handbook FAA-H-8083-2

Preflight Decision-Making Tool

3-P Model

Perceive: Pilot perceive the hazard
Process: Evaluate the level of risk (e.g., Alternatives)
Perform: Mitigate or eliminate the risk



Source: Risk Management Handbook FAA-H-8083-2

https://www.ifr-magazine.com/training-sims/good-pilot-decision-making/

VNR Risk Assessment Study

- **Purpose: To determine the feasibility of an automated VFR Not Recommended (VNR) service**

Initial VNR Study: Scenario

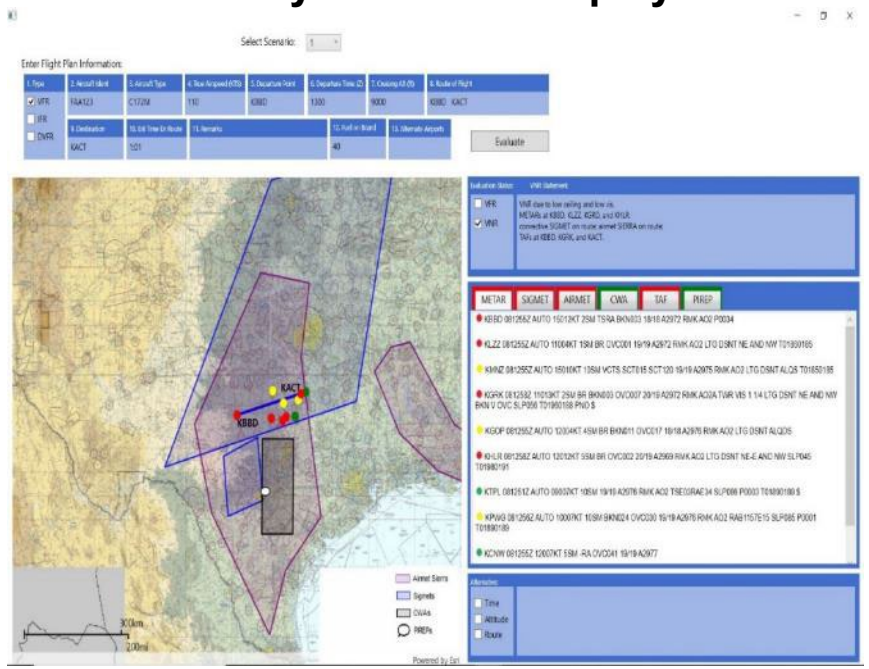
- Scenario Description
  - Departure and destination airports show current and forecasted VFR conditions
  - Thunderstorms are present to the west, moving north and parallel to the route
  - Enroute weather shows only a minor possibility of small, localized areas of precipitation

Results

- Wide variety in both the usage and interpretation of weather products resulted in inconsistent recommendations (for some scenarios).
- Lack of a procedure indicated a need for procedure standardization.

	VFR	VNR
FSS	17	3
PILOT	9	11

Second VNR Study: VNR Graphical User Interface Study- Notional Display



Results

- Go/no-go decision is correlated with pilot experience, minimums, and skills
- No single threshold for a go/no-go decision was found
- Need to consider when automating VNR

Modified FRAT Tool – Notional

- includes weather component -

FAAST FRAT **(Flight Risk Assessment Tool)**

Pilot Name	
Aircraft	
Date	
Departure Airport	
Arrival Airport	

Pilot	Yes	Your Value
Less than 50 Hours in Aircraft or Avionics Type		5
Less than 15 hours in last 90 days		0
Flight will occur after work		0
Less than 8 hours sleep prior to flight		5
Dual Instruction Received in last 90 days		0
WINGS Phase Completion in last 6 months		0
Instrument Rating current and proficient		-3
Flight Conditions		
Twilight or Night		0
Mountainous Terrain		0
Airport		
Non-towered Airport or tower closed at ETD or ETA		5
Runway length less than 3,000 Feet		0
Wet or soft field Runway		3
Obstacles on Approach and/or departure		0
VFR Flight Plan		
No Weather Reporting at destination		0
Flight Plan filed and activated		0
ATC Flight Following used		0
IFR Flight Plan		
No Weather Reporting at destination		0
Approaches - Instrument Pilots		
Best Available Approach		
Precision Approach		-2
Non precision Approach		0
No Instrument Approach		0
Circling Approach		0

Weather Hazards - Departure	VFR	Marginal	IFR	
Convective SIGMETs	Y			0
CWAs	Y			0
AIRMET SIERRA	Y			0
METARs	Y			0
TAFs	Y			0
PIREPs	Y			0
Radar		Y		3
Satellite	Y			0

Weather Hazards - En Route	VFR	Marginal	IFR	
Convective SIGMETs	Y			0
CWAs	Y			0
AIRMET SIERRA	Y			0
METARs	Y			0
TAFs	Y			0
PIREPs	Y			0
Radar		Y		3
Satellite	Y			0

Weather Hazards - Destination	VFR	Marginal	IFR	
Convective SIGMETs	Y			0
CWAs	Y			0
AIRMET SIERRA	Y			0
METARs		Y		3
TAFs	Y			0
PIREPs	Y			0
Radar	Y			0
Satellite	Y			0

Total Risk Value **22**

Pilot	Experience	Low Risk	Moderate Risk	High Risk
VFR	<100 In Type	5 to 15	15 to 20	> 20
VFR	>100 In Type	15 to 20	20 to 25	>25
IFR	<100 In Type	20 to 25	25 to 30	>30
IFR	>100 In Type	25 to 30	30 to 35	>35

Instructions: Check the Yes box opposite each statement that applies to your flight. Then compare your total risk value to the Risk Matrix Chart.

- Go/no-go decisions correlate with pilot experience, minimums, and skills
  - This sometimes results in a go/no-go decision that seems at odds with the VFR/VNR recommendation/statement

Summary: Addressing the Gaps

- Adverse weather remains a major cause of general aviation accidents
- Major contributing factor in weather-related accidents may be pilot
  - Lack of weather Knowledge
  - Inability to interpret weather displays

Addressing the Gaps

- Increase interpretability and usability of weather products:
  - Design based on mental model of users, not meteorologist
  - Focus products on what users need to know to make effective decision
- Develop more targeted weather training focused on:
  - How to interpret weather products
  - Experience interpreting weather information in various situations
  - Strengths/weaknesses of each weather product and when most accurate