Assessing GA Pilots' Preflight Weather Planning Mental Models

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Purpose

To assess GA pilots' ability to:

OBTAIN THE APPROPRIATE WEATHER INFORMATION

INTERPRET THE DATA

APPLY THE INFORMATION TO A GIVEN FLIGHT ROUTE

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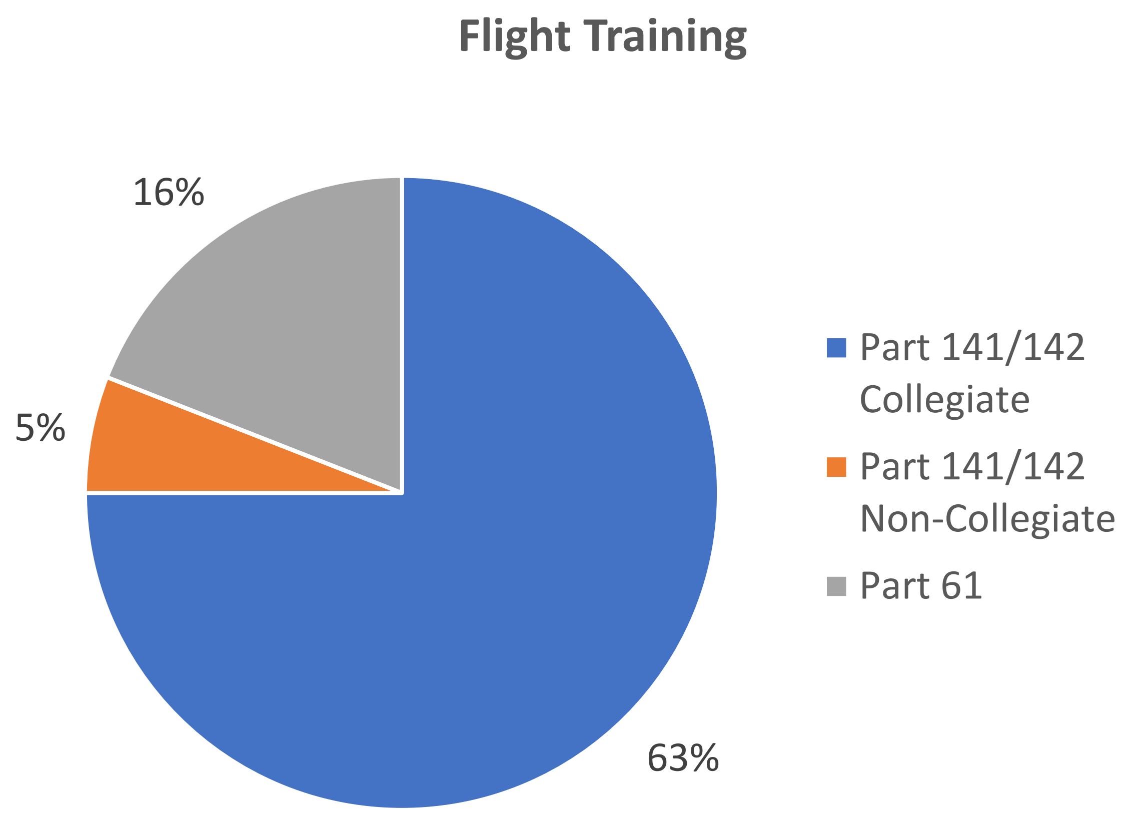
METHOD

Participants

- n = 84 GA pilots
  - 24 Private
  - 20 Private w/ Instrument
  - 20 Commercial w/ Instrument
  - 20 Certified Flight Instructors (CFI/CFII)
- Age
  - M(SD) = 22 (3.32)
- Location: Southeastern region



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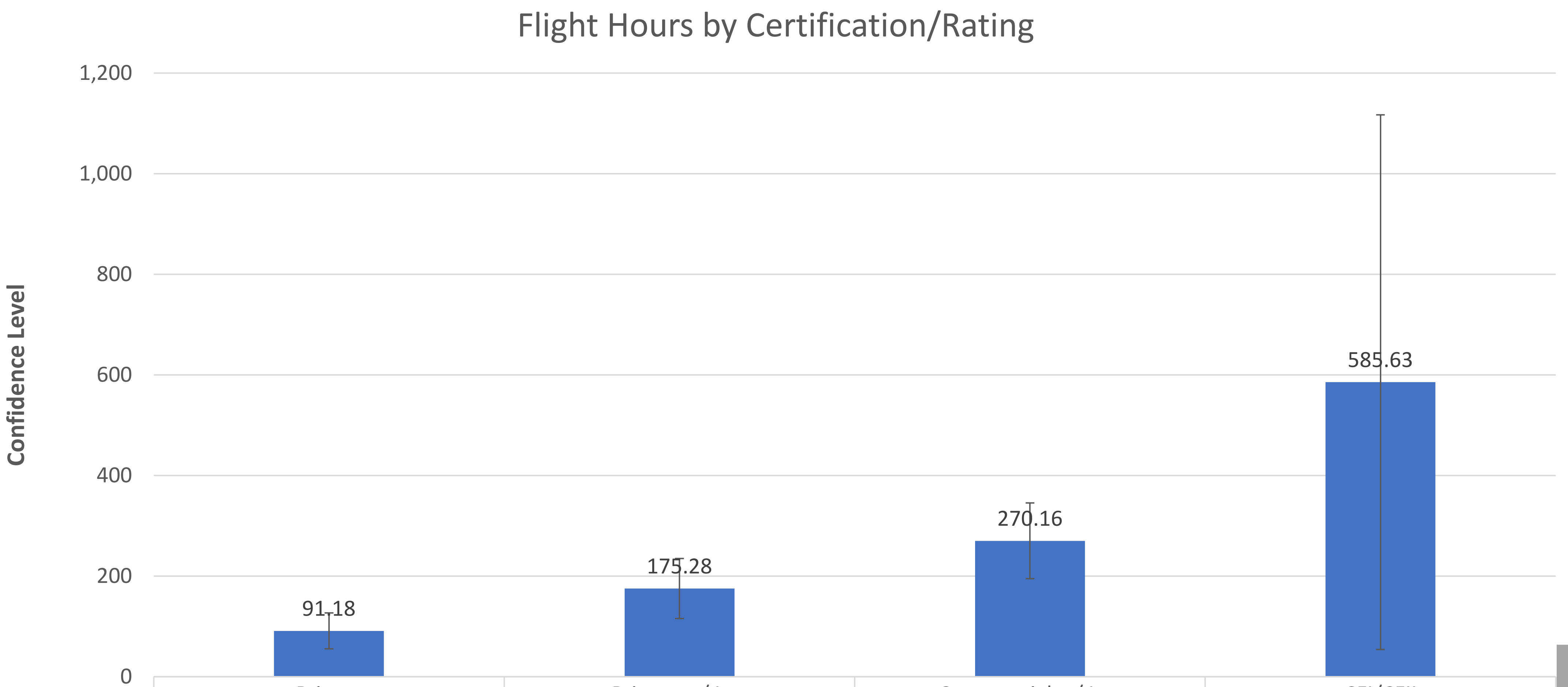
Flight Hours by Certification/Rating



	Private	Private w/ Ins.	Commercial w/ Ins.	CFI/CFII	Total M (SD)
Flight Hours	91.18	175.28	270.16	585.63	**271.54 (320.19)**

Certification/Rating

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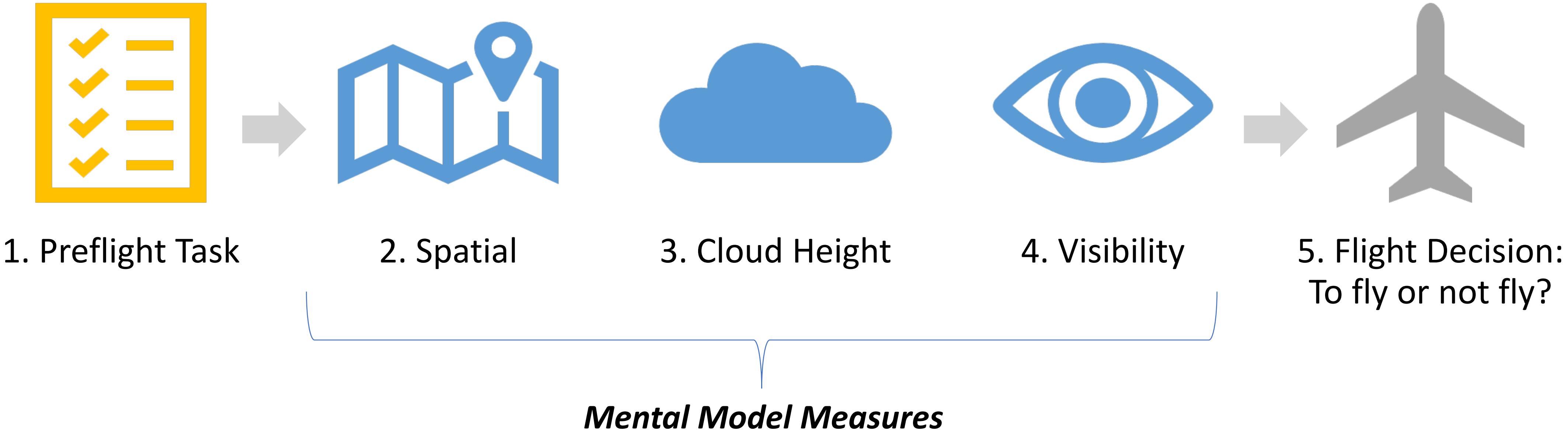
Procedure


1. Preflight Task
2. Spatial
3. Cloud Height
4. Visibility
5. Flight Decision:
To fly or not fly?
Mental Model Measures

Material: Preflight Task

- **High Fidelity Preflight Scenario**
  - Closely mimic real preflight tasks and processes.
- Pilots developed a weather briefing based on "current" and "forecasted" weather products
- WX data captured from the Aviation Weather Center (AWC, 2017)
  - Slightly modified
- Formatted to match AWC website
- Mockup website created using Wix.com

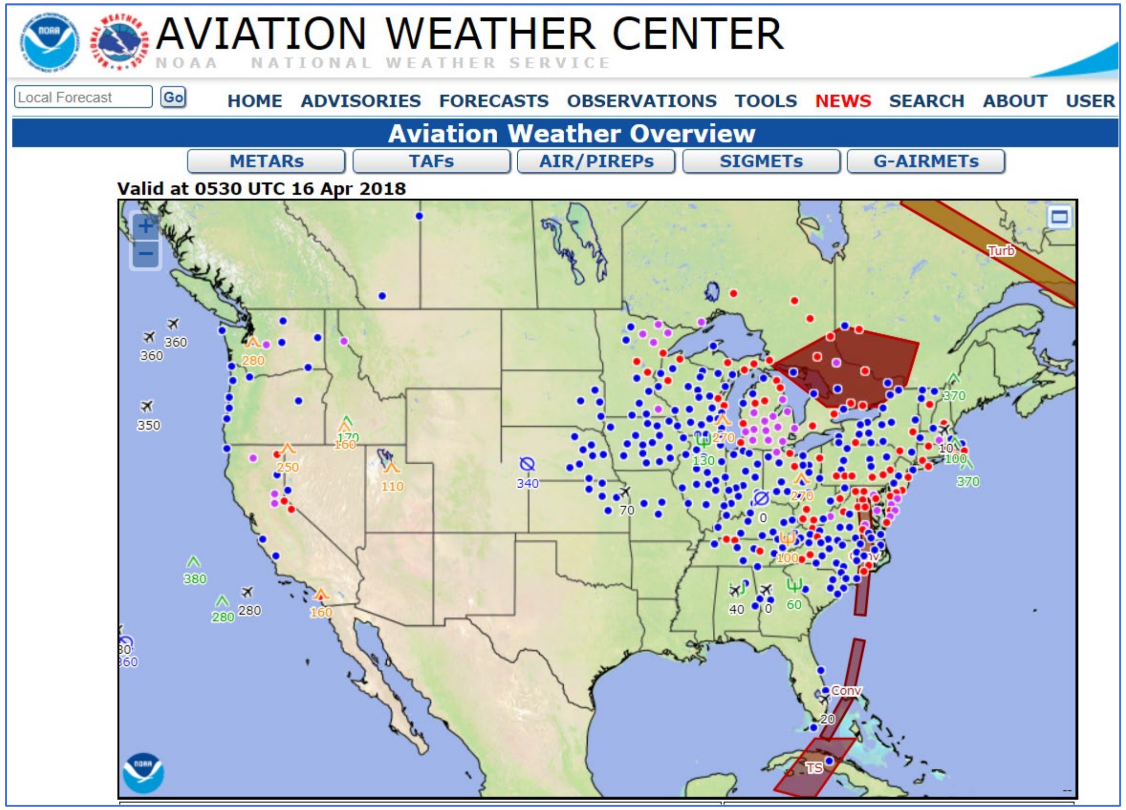


Figure 3. Aviation Weather Center **original** website

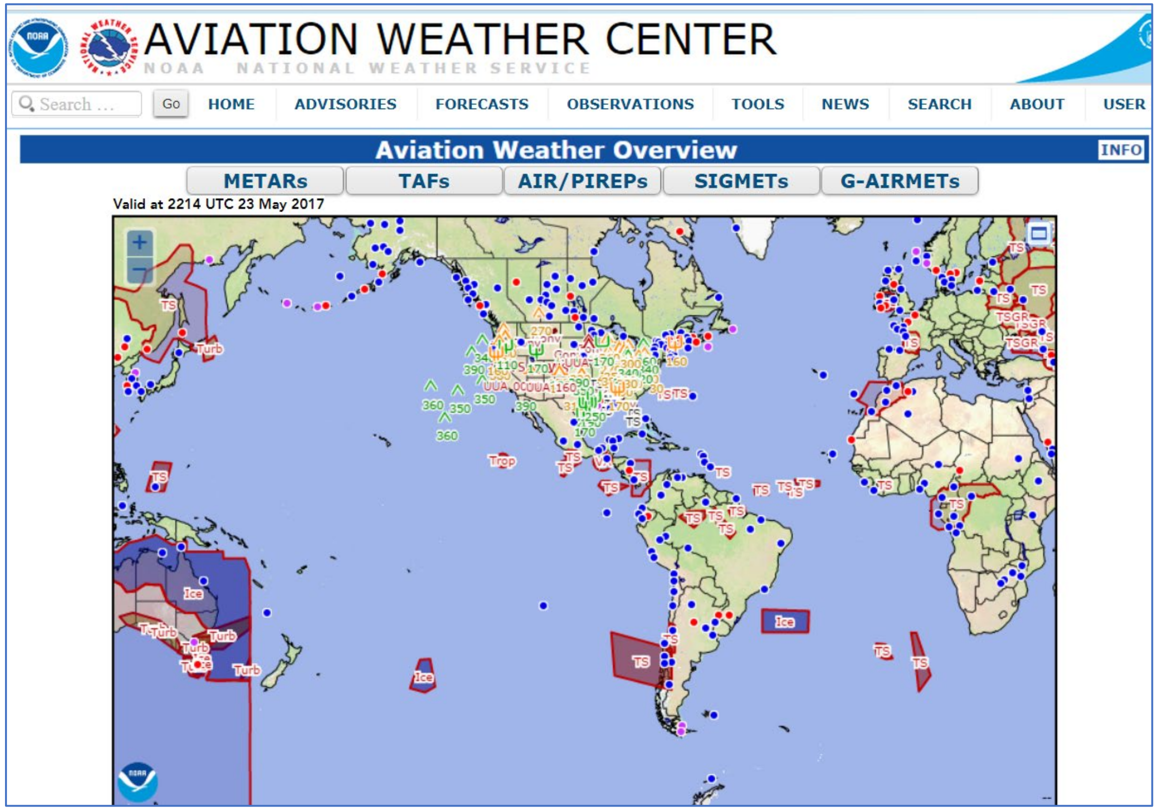
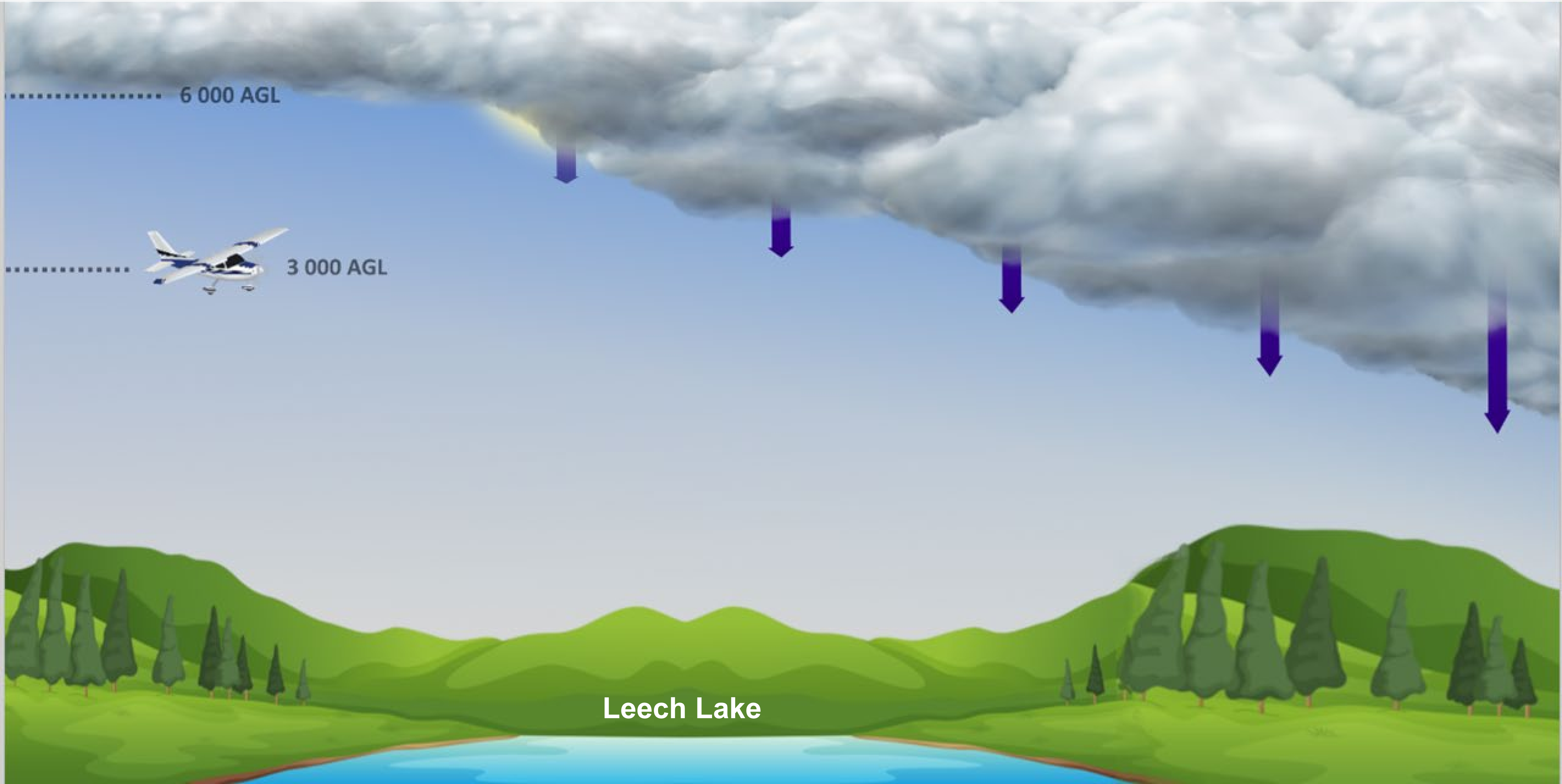


Figure 4. Aviation Weather Center **mockup** website

Inflight Weather Scenario: Lowering Ceiling During Cruise



Mental Model Measure: Spatial

Software: IHMC CmapTools

Scored:

- # of correct
- # of false alarm
- # of miss

- **Flight Category** (e.g., VFR/MVFR/IFR/LIFR)
- **Sky Condition** (CLR, FEW, SCT, BKN, OVC)
- **Weather Hazards** (e.g., obscurations, precipitation)
- **Time:** ETE, ETA
- **Confidence**

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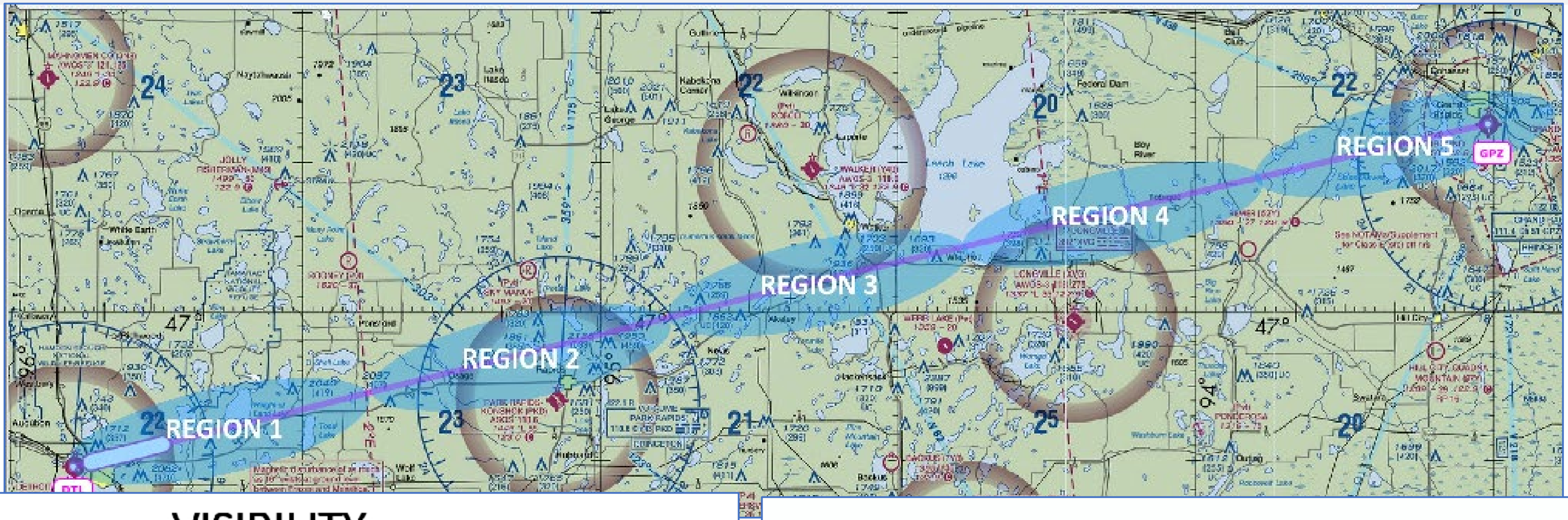
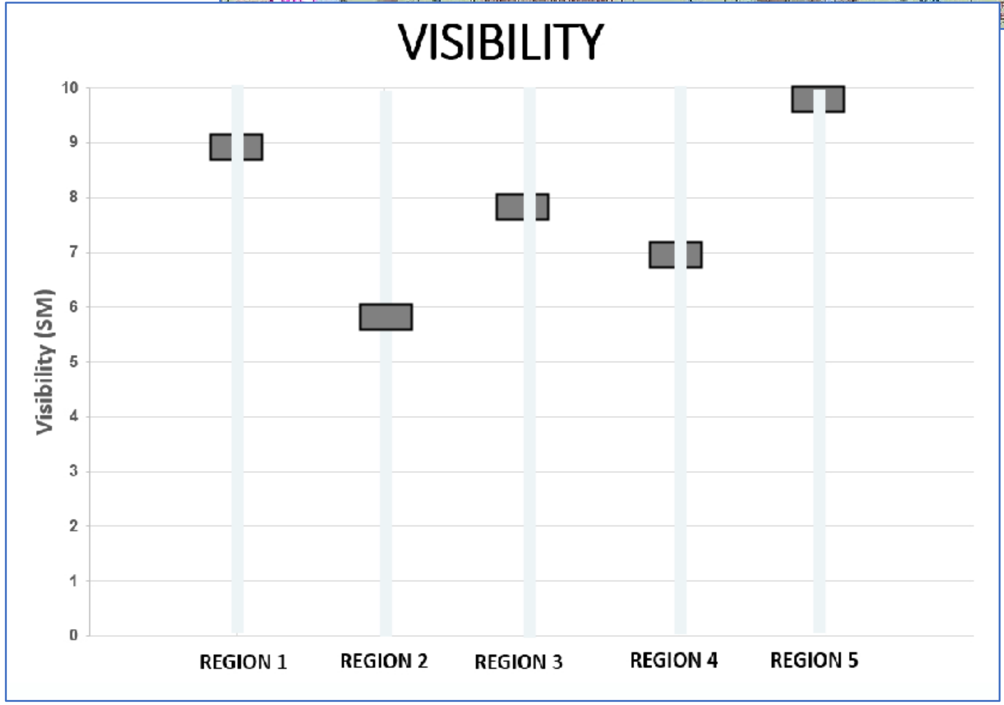
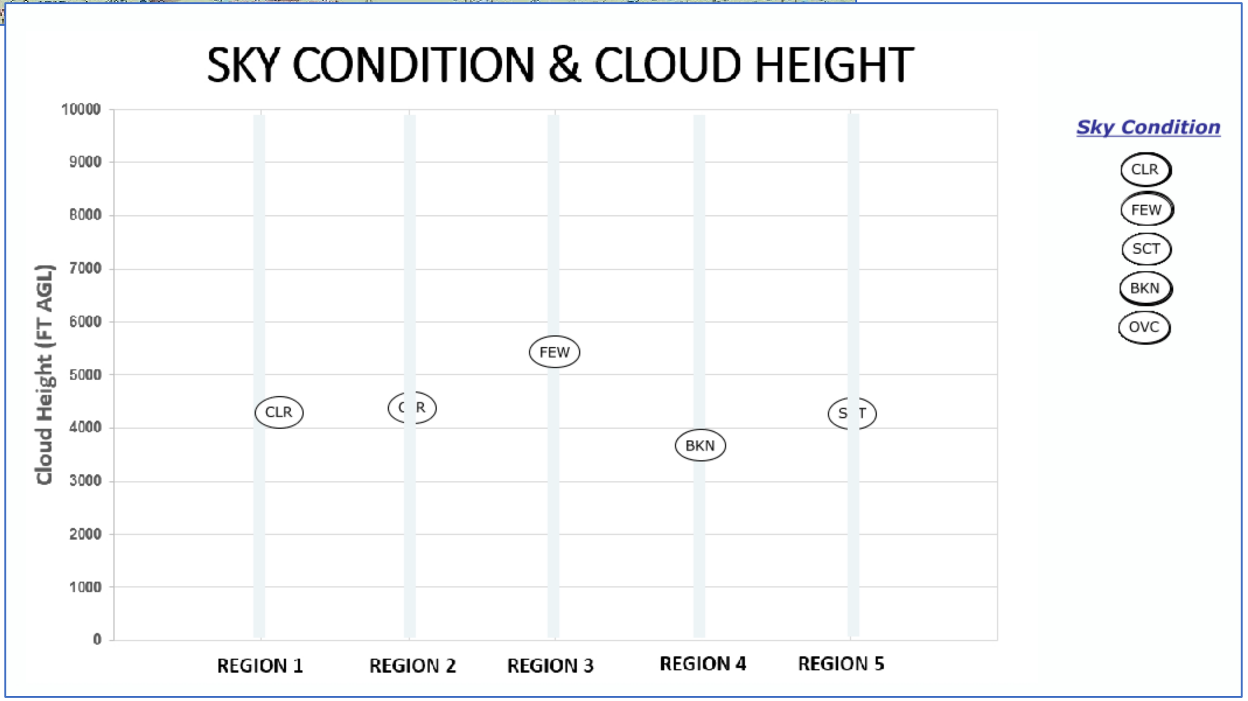
Mental Model Measure: Cloud Heights & Visibility







RESULTS

Preflight Results: Products Accessed

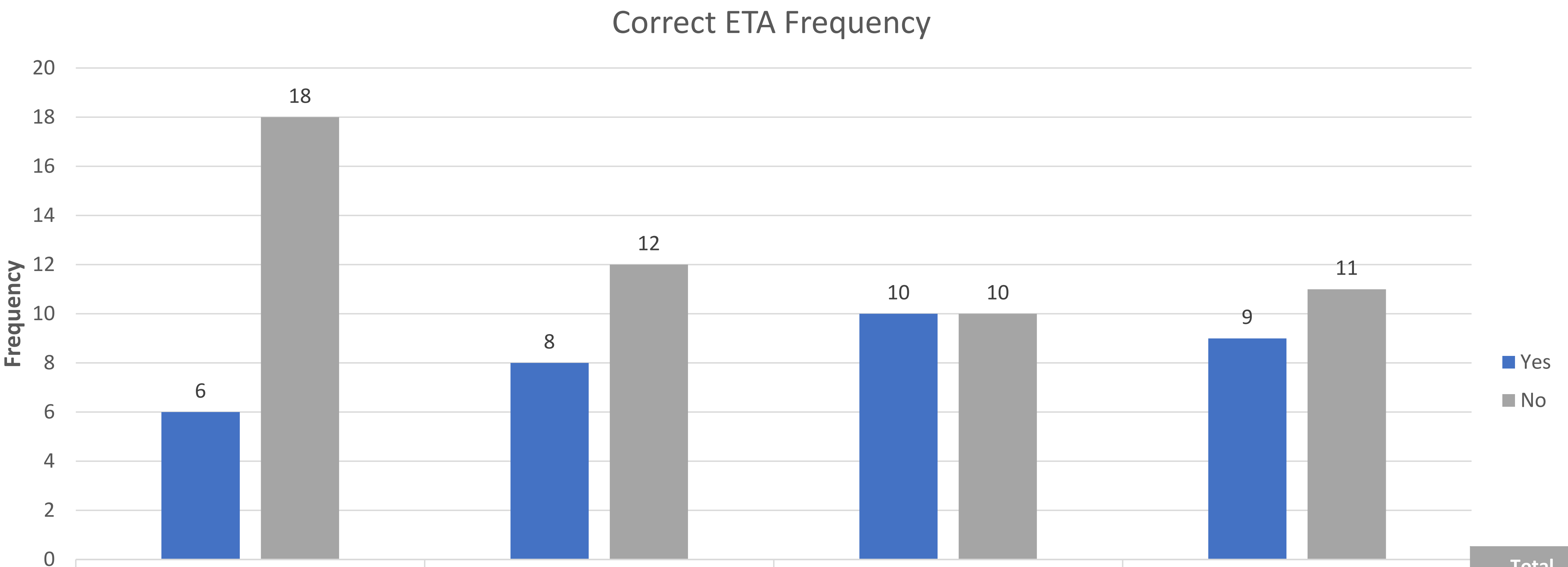
	n products	Private *n* = 24 M (SD)	Private w/ Instrument *n* = 20 M (SD)	Commercial w/ Instrument *n* = 20 M (SD)	CFI/CFII *n* = 20 M (SD)	Total *n* = 84 **M (SD)**
Observation	6	2.04 (.81)	3.05 (1.16)	2.70 (1.46)	2.95 (1.39)	**2.65 (1.26)**
Analysis	3	.33 (.57)	1.10 (.70)	1.05 (.83)	.84 (.83)	**.81 (.78)**
Forecast	16	4.13 (2.88)	6.33 (2.92)	5.30 (3.80)	5.89 (3.28)	**5.36 (3.28)**
Total	**25**	**6.24 (3.68)**	**9.57 (4.82)**	**8.23 (5.58)**	**9.20 (5.19)**	**8.23 (4.93)**

- **Private accessed** significantly ***less products*** than **private w/ instrument**, F(3, 71.79) = 3.81, *p* = .013, partial eta squared = .13
- No sig. difference between other ratings

Products Accessed	f (n = 84)
Observation	
METAR	82
RADAR	57
Satellite Images	35
Analysis	
CVA	39
Surface Analysis	25
Forecast	
TAF	51
Area Forecast *(Discontinued)*	57
Wind Aloft	79
Convective SIGMET	29
Low-Level Sig WX Chart	32
GAIRMET 3hr	42
GAIRMET Sierra (C & V)	7

Mental Model Results: ETA in Zulu

- **No significant difference** between pilot certifications/ratings *on estimating the correct ETA in Zulu.*



	Private	Private w/ Ins.	Commercial w/ Ins.	CFI/CFII	Total
Yes	6 (25%)	8 (40%)	10 (50%)	9 (45%)	**33 (39%)**
No	18 (75%)	12 (60%)	10 (50%)	11 (55%)	**51 (61%)**

Certification/Rating

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Mental Model Results: Spatial Weather Recall

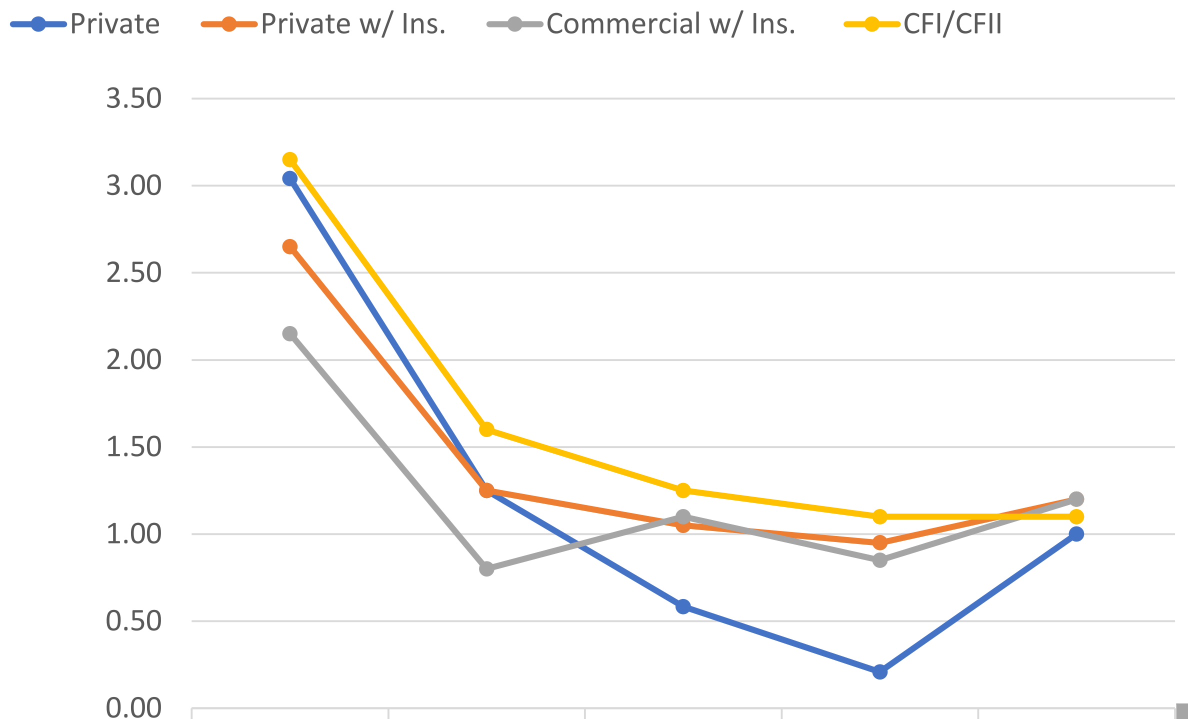
Pilot Certification Main Effect:

- **No sig. difference** between ***pilot certifications*** on **correct weather items identified** by region.

By Region Main Effect:

- Pilots **correctly identified more** weather items in ***Region 1*** *(i.e., departure)* than any other region, $p < .01$
- **No sig. difference** between **Regions 3, 4, & 5**.
    - Pilots identified **less correct weather items** for their ***route*** and at their ***destination***

Average Correct Weather Items by Region



	Region 1	Region 2	Region 3	Region 4	Region 5	Total Map
Private	3.04	1.25	0.58	0.21	1.00	**6.67 (3.19)**
Private w/ Ins.	2.65	1.25	1.05	0.95	1.20	**8.00 (3.21)**
Commercial w/ Ins.	2.15	0.80	1.10	0.85	1.20	**7.55 (3.24)**
CFI/CFII	3.15	1.60	1.25	1.10	1.10	**9.30 (4.05)**
Total	**2.76 (1.49)**	**1.23 (1.05)**	**.98 (1.07)**	**.75 (1.16)**	**1.12 (1.01)**	**7.82 (3.50)**

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Mental Model Results: Confidence

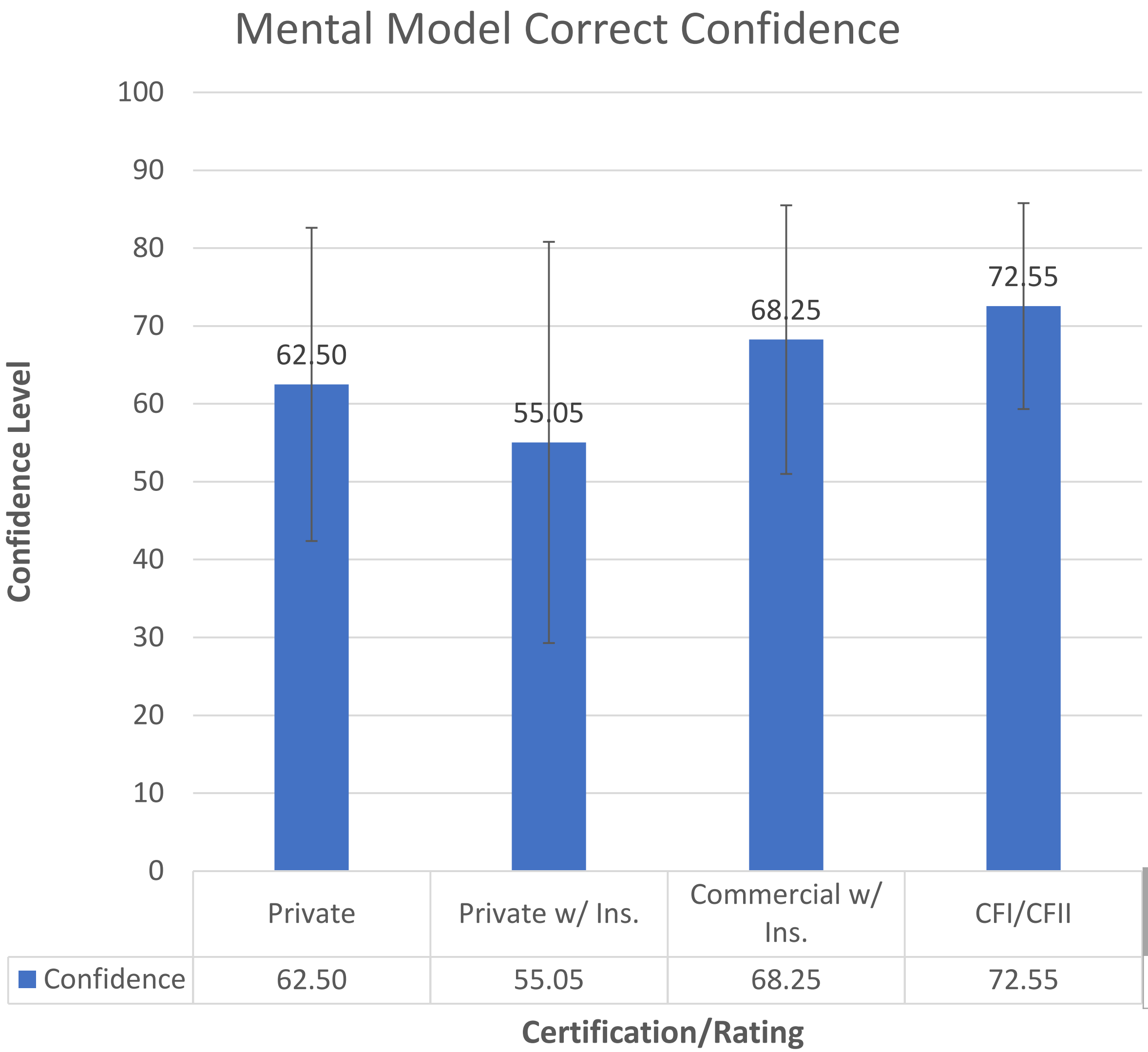
- **Private w/ instrument pilots** had ***sig. less confidence*** on *their mental model being correct* than **CFI/CFII,** $p = .034$

- No other sig. differences occurred.

<u>Correlation</u>:

  - A **small, positive relationship occurred** between *number of correct weather conditions identified* and *mental model correct confidence levels,*
    $r = .24$, $n = 84$, $p = .03$

  - Pilots who **identified higher number** of *correct weather conditions* were **associated** with ***higher confidence levels.***



Total M (SD)
64.49 (20.35)

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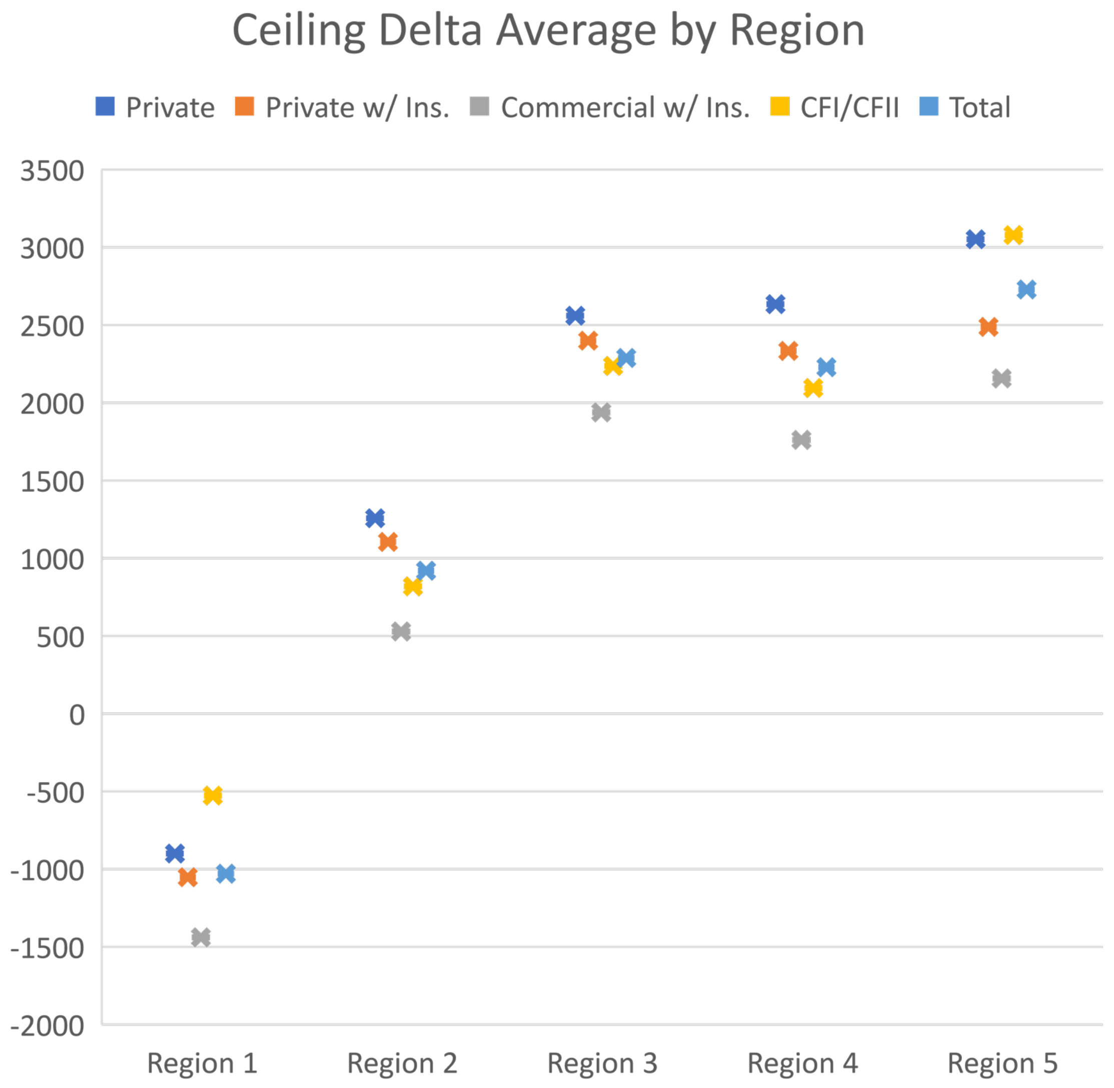
Mental Model Results: Cloud Height

Frequency of Estimated Ceiling Correct by Region

	Private *n* = 24	Private w/ Instrument *n* = 20	Commercial w/ Instrument *n* = 20	CFI/CFII *n* = 20	Total *n* = 84
	f	*f*	*f*	*f*	***f***
Region 1	8	7	6	6	**27**
Region 2	0	2	8	1	**11**
Region 3	1	5	2	3	**11**
Region 4	1	3	2	5	**11**
Region 5	2	2	4	1	**9**
All regions	0	0	0	0	**0**



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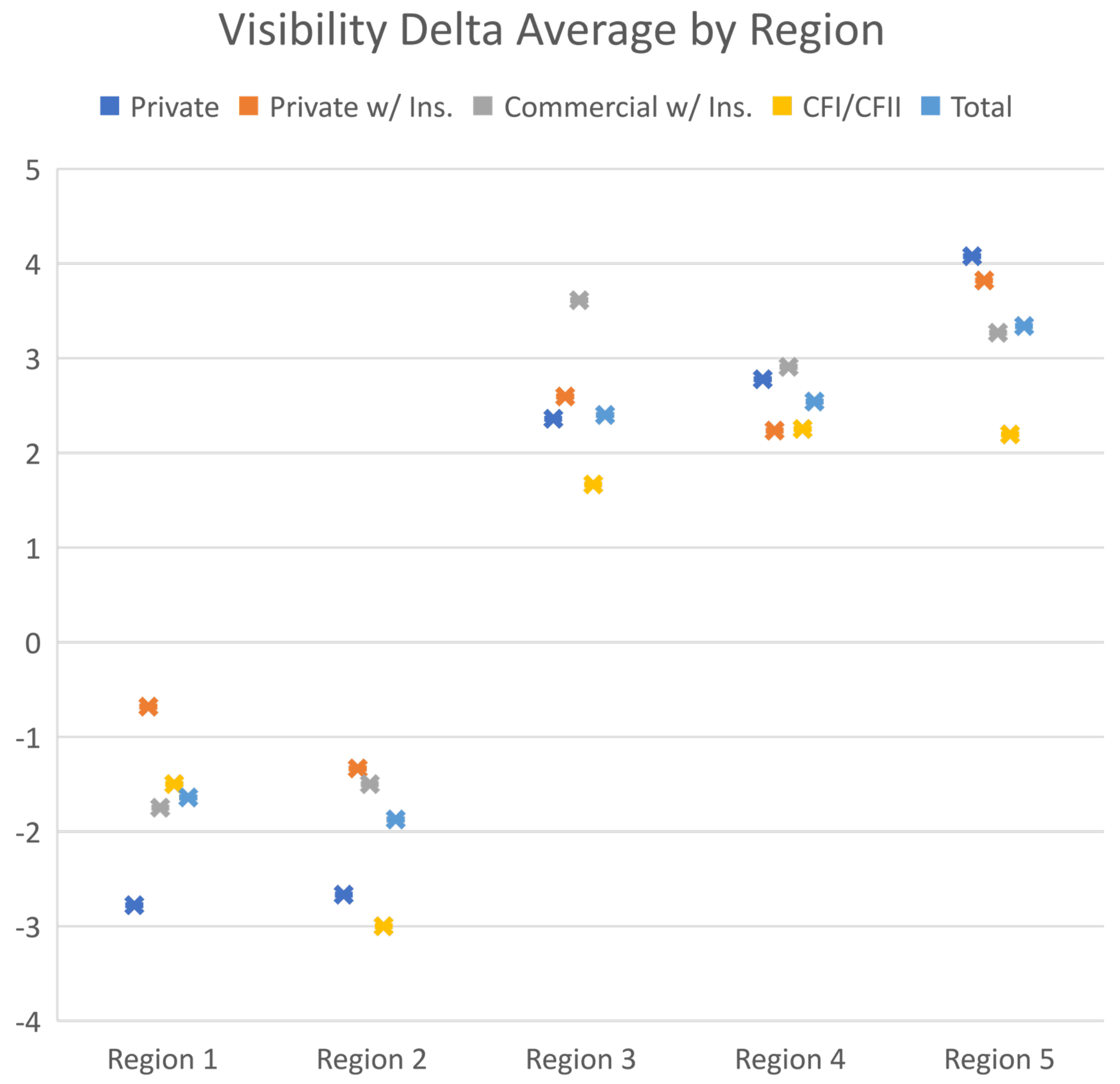
Mental Model Results: Visibility

Frequency of Estimated Visibility Correct by Region

	Private *n* = 24	Private w/ Instrument *n* = 20	Commercial w/ Instrument *n* = 20	CFI/CFII *n* = 20	**Total *n* = 84**
	f	*f*	*f*	*f*	***f***
Region 1	21	20	17	20	**78**
Region 2	21	17	12	18	**68**
Region 3	3	4	11	3	**21**
Region 4	4	5	9	6	**24**
Region 5	4	6	7	2	**19**
All Regions	0	1	2	0	**3**



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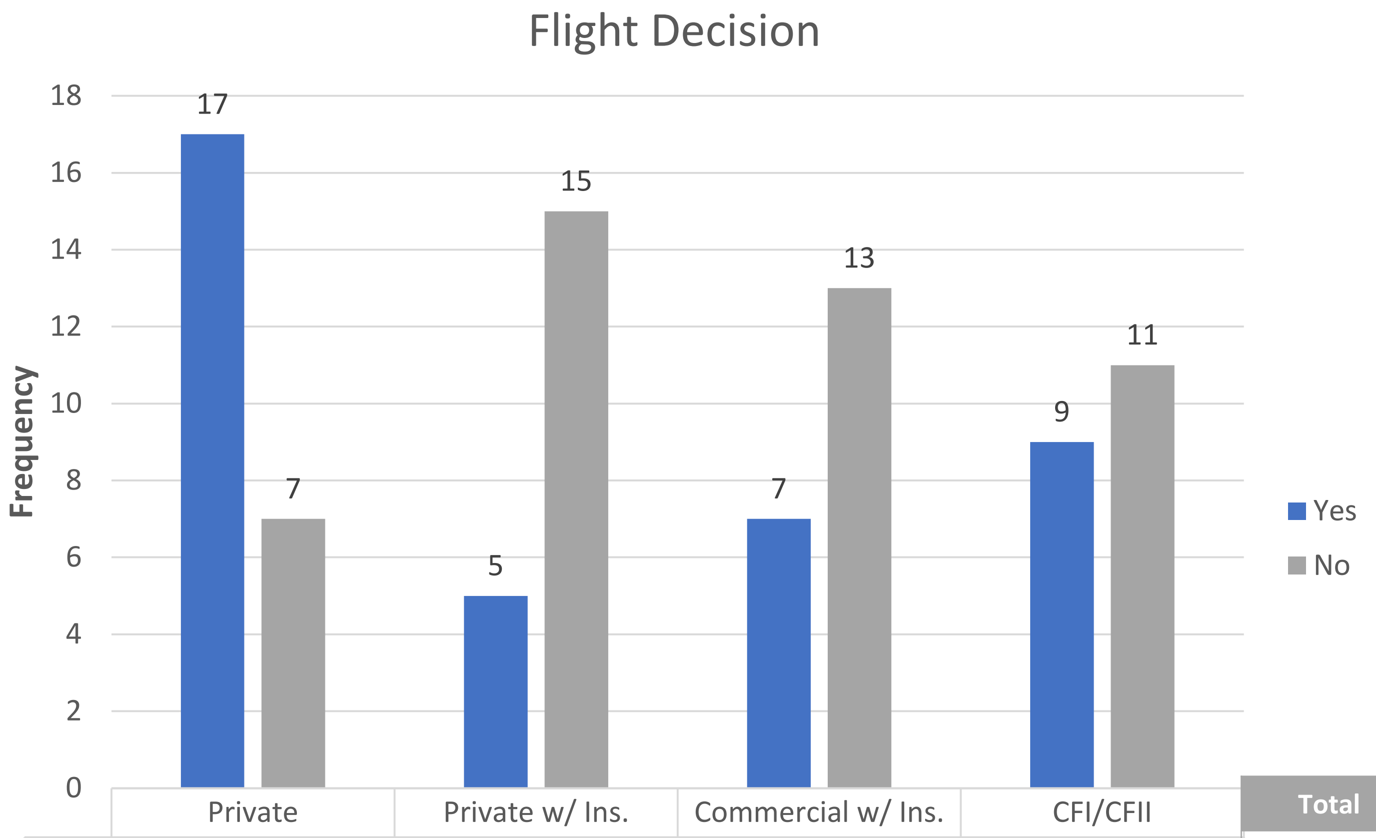
Flight Decision Results: Go or No Go?

- **Sig. difference** between *Private* and *Private w/ Instrument* (p = .013).
  - *Private pilots (71%)* decided to **fly more than** *private with instrument (25%)*

- No other sig. differences occurred.

<u>Correlation</u>:
  - A **small, negative relationship occurred** between pilots' *hit rate* (number of correct weather conditions/total items identified) and *decision to fly or not,*
    r = -.24, n = 84, p = .03

  - Pilots who **identified a higher number** of *correct weather conditions out of their total mental model weather items* were **associated** with **deciding not to fly** the given route.



	Private	Private w/ Ins.	Commercial w/ Ins.	CFI/CFII	Total
Yes	17 (71%)	5 (25%)	7 (35%)	9 (45%)	**38 (45%)**
No	7 (29%)	15 (75%)	13 (65%)	11 (55%)	**46 (55%)**

Certification/Rating

CONCLUSION

Summary

- Pilots **struggled at depicting** weather **along route**
- **Held incorrect weather expectations** for most of the route and at the destination airport.
  - Depicted destination weather conditions as VFR, whereas the conditions (e.g., ceiling, visibility) were much lower in the MVFR/IFR range.
- Pilots (especially low-level) **may not be accessing enough forecast products** to gain a better mental model of what weather to expect along their route
  - ***Relying on observation information*** (e.g. METAR) ***for destination***, instead of accessing the appropriate forecast products (e.g., area forecast, LLSigWX).

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Summary continued

- Furthermore, pilots **<u>may not be</u>**:
  - Accessing the correct issued/valid times for forecast weather products.
  - Reading/Interpreting the weather information in its entirety
    (e.g., reading all sky conditions on a METAR: SCT 045, BKN 055, OVC 060).
  - Calculating weather condition heights correctly.

- **Measures used in this study** can be **used as a training tool** to help instructors determine if trainee pilots are interpreting and applying weather information correctly to a flight route.

- Need more **high fidelity preflight weather scenarios** for **pilots to practice** and become more aware of what weather to expect along their route.

- Study **highlights** the **potential need** to **redesign** aviation weather products **for more system transparency** (e.g., include specifications/limitations of the products in the display)

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QUESTIONS

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