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Assessing GA Pilots' Preflight Weather Planning Mental Models

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Purpose

To assess GA pilots' ability to:



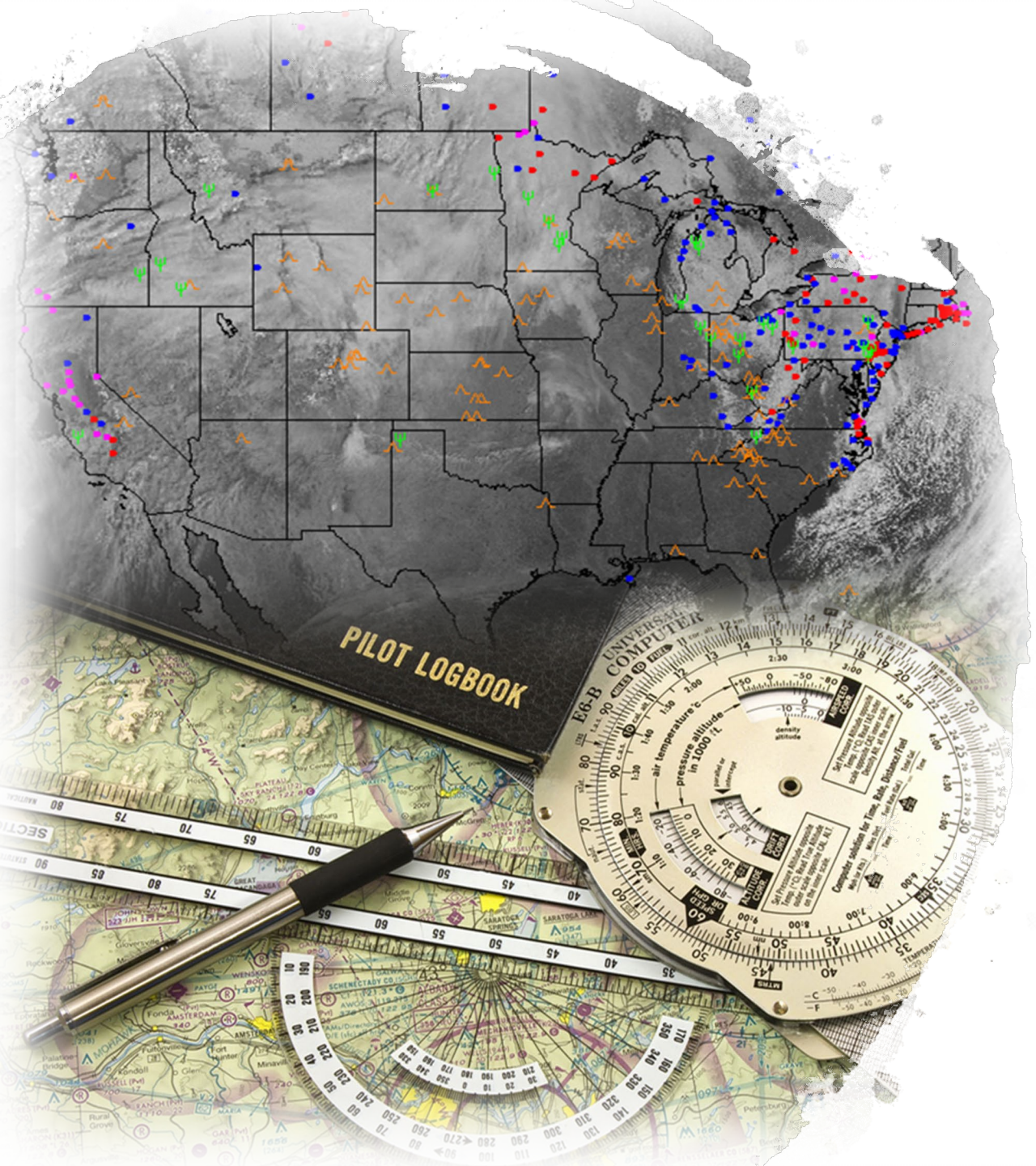
OBTAIN THE APPROPRIATE
WEATHER INFORMATION



INTERPRET THE DATA



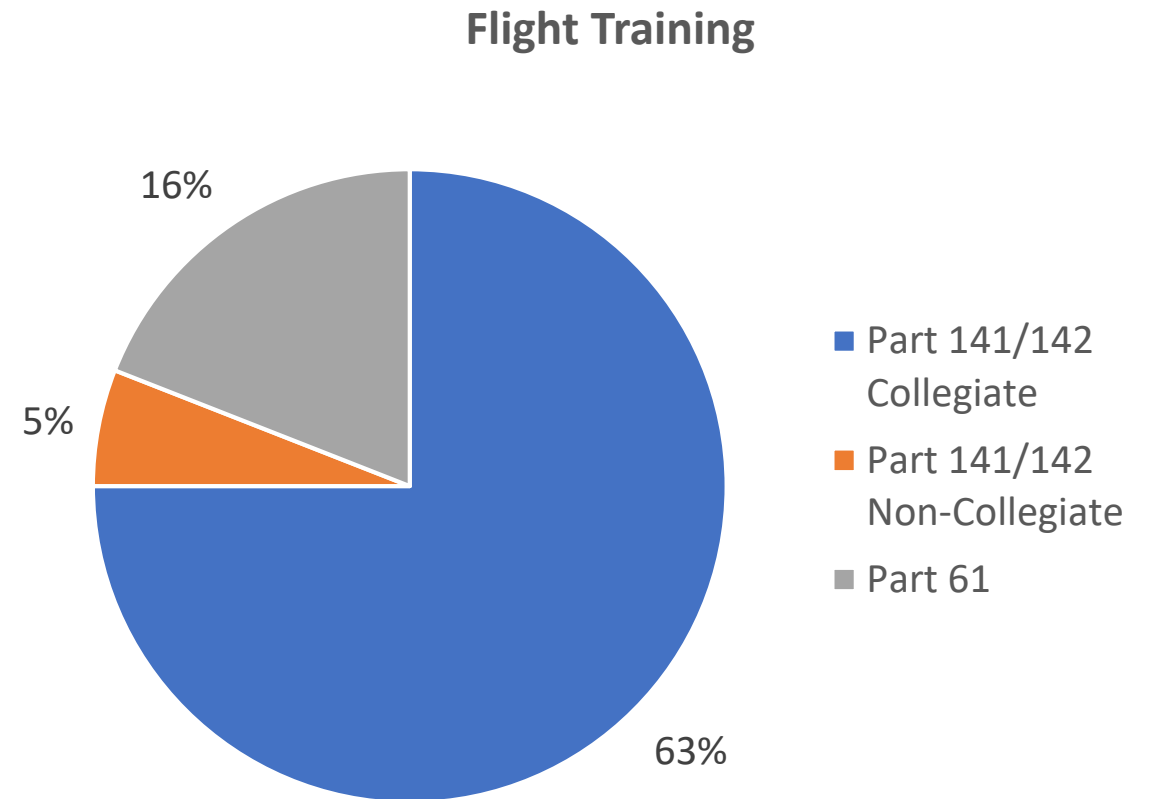
APPLY THE INFORMATION
TO A GIVEN FLIGHT ROUTE



METHOD

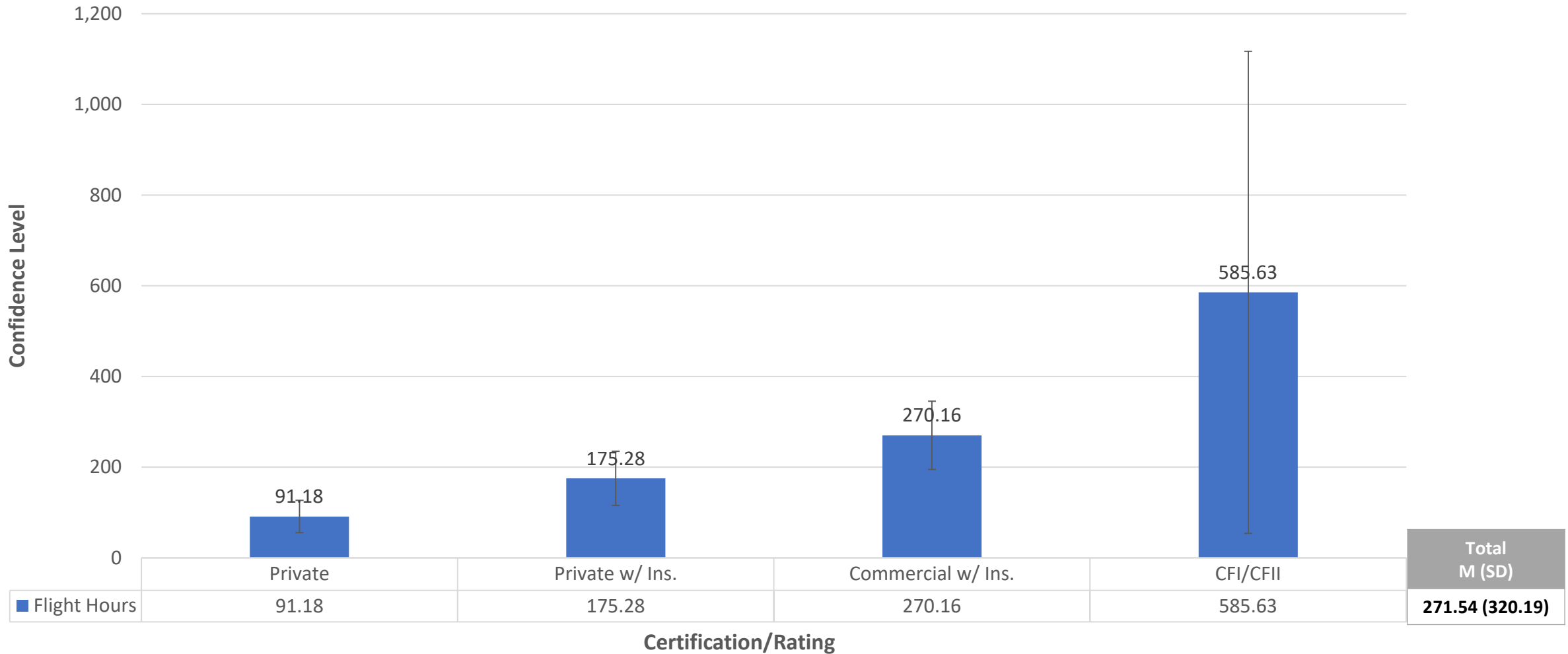
Participants

- 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

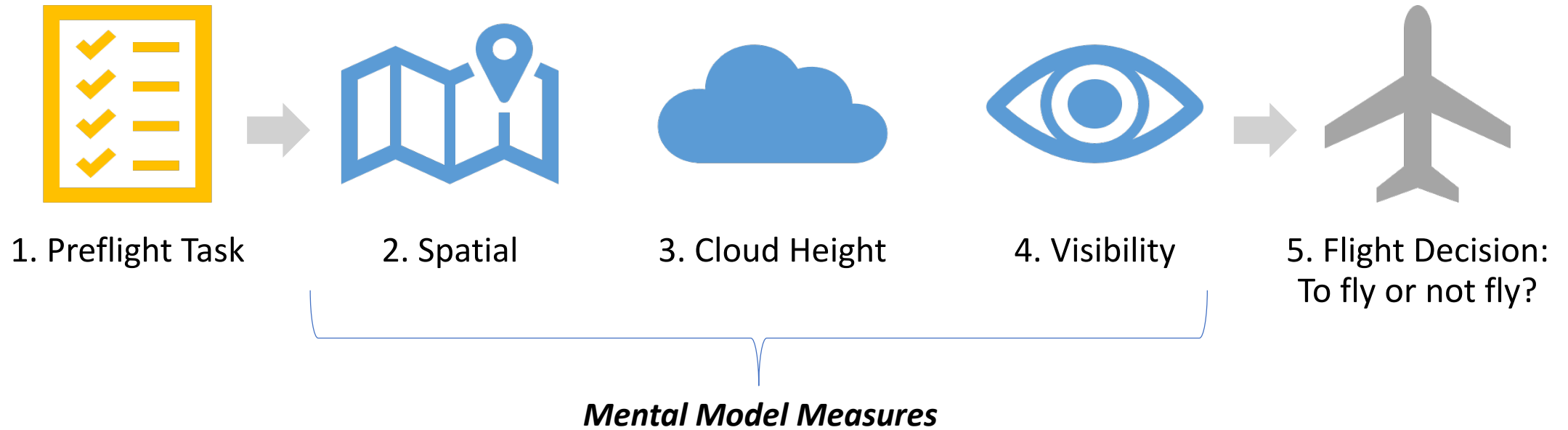


Flight Hours by Certification/Rating

Flight Hours by Certification/Rating



Procedure



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

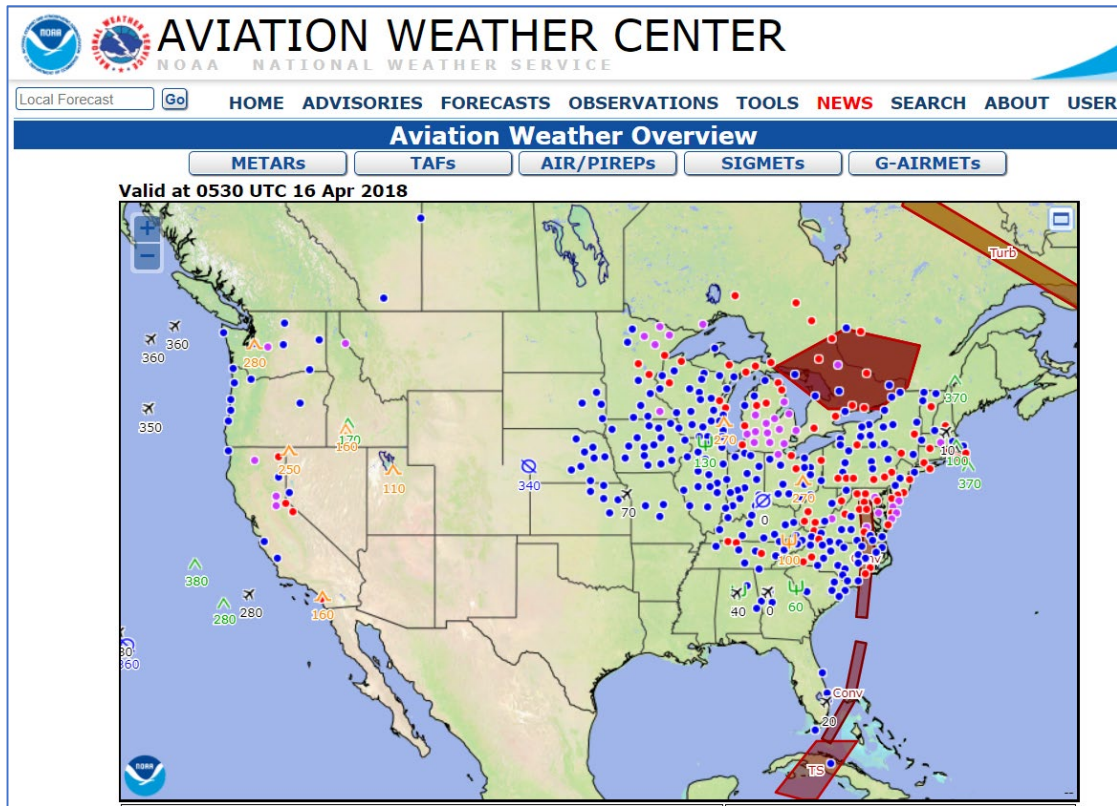


Figure 3. Aviation Weather Center **original** website

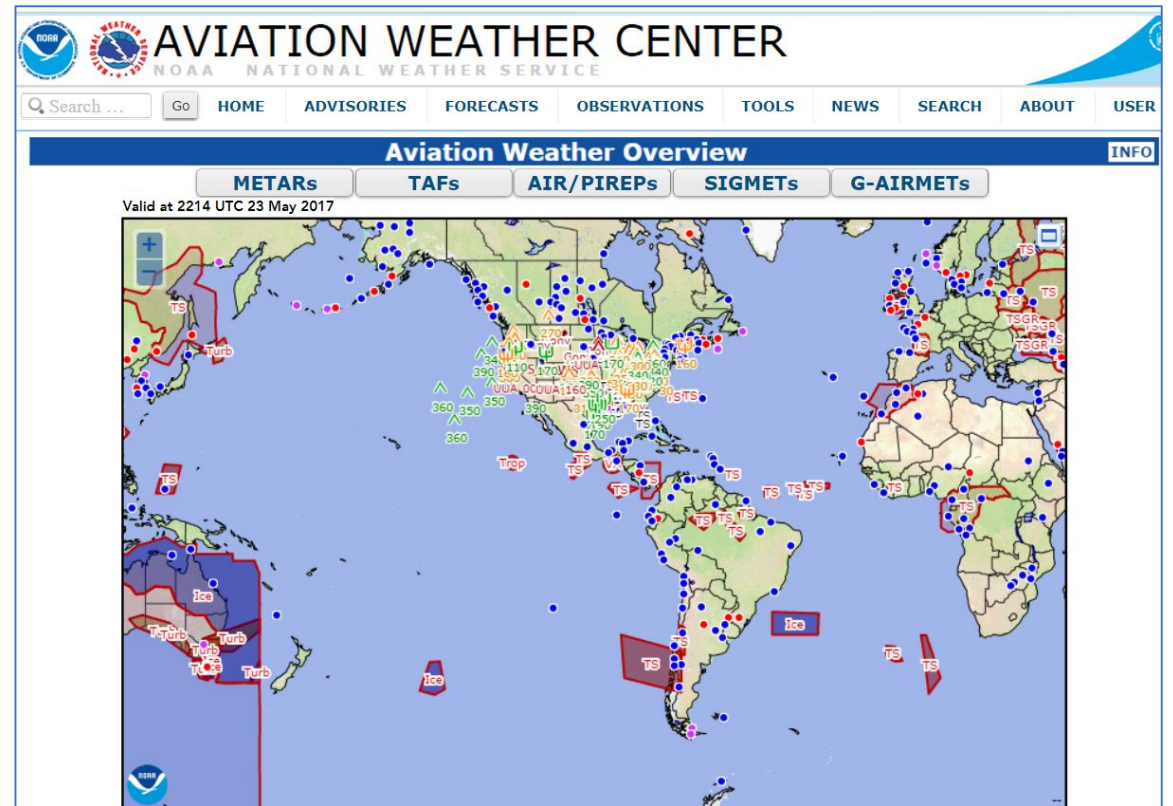
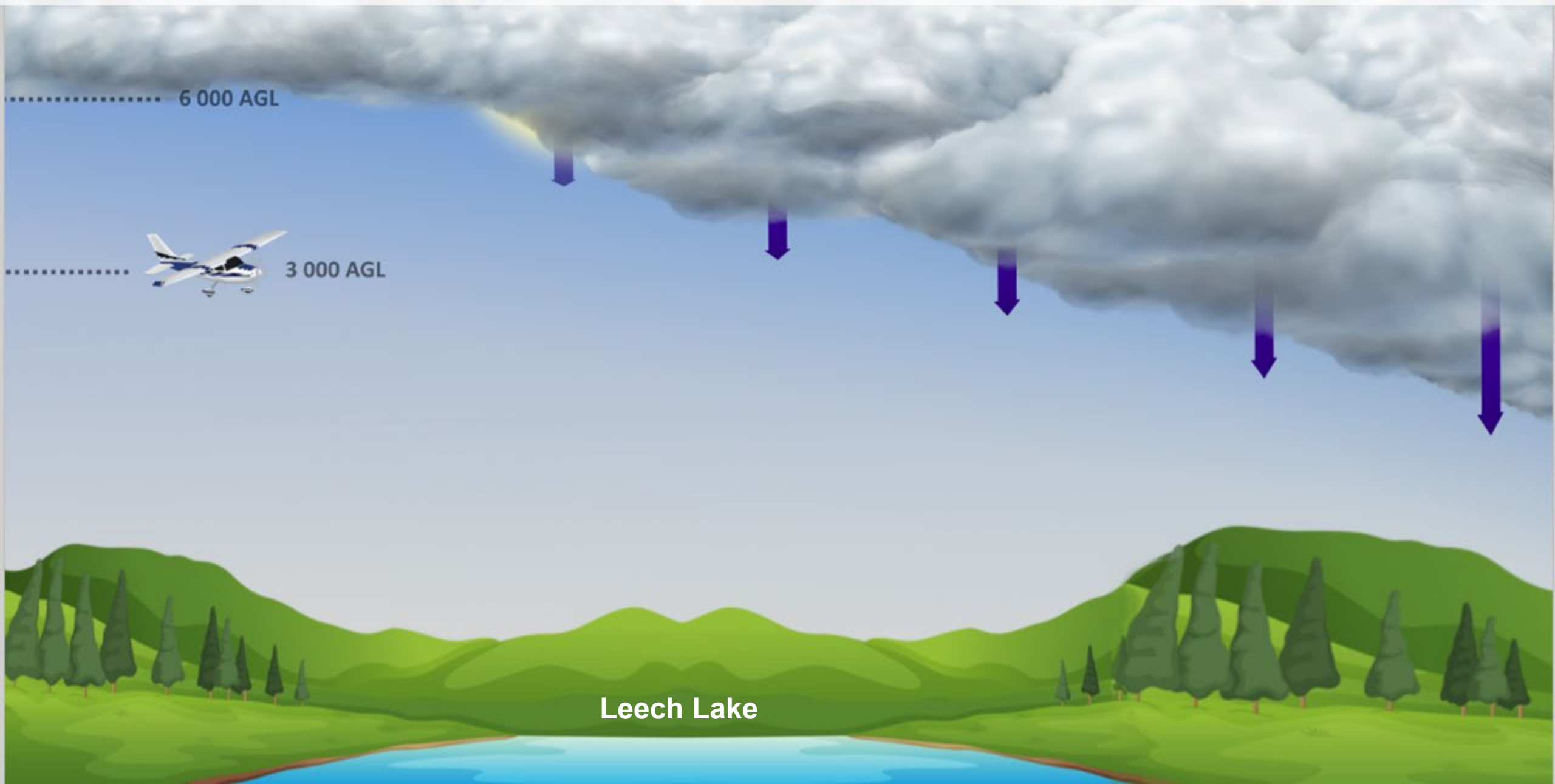


Figure 4. Aviation Weather Center **mockup** website

Inflight Weather Scenario: Lowering Ceiling During Cruise



Mental Model Measure: Spatial

Altitude (AGL)

Less than 010 AGL	060 AGL
010 AGL	065 AGL
015 AGL	070 AGL
020 AGL	075 AGL
025 AGL	080 AGL
030 AGL	085 AGL
035 AGL	090 AGL
040 AGL	095 AGL
045 AGL	100 AGL
050 AGL	Greater than 100 AGL
055 AGL	

Descriptor

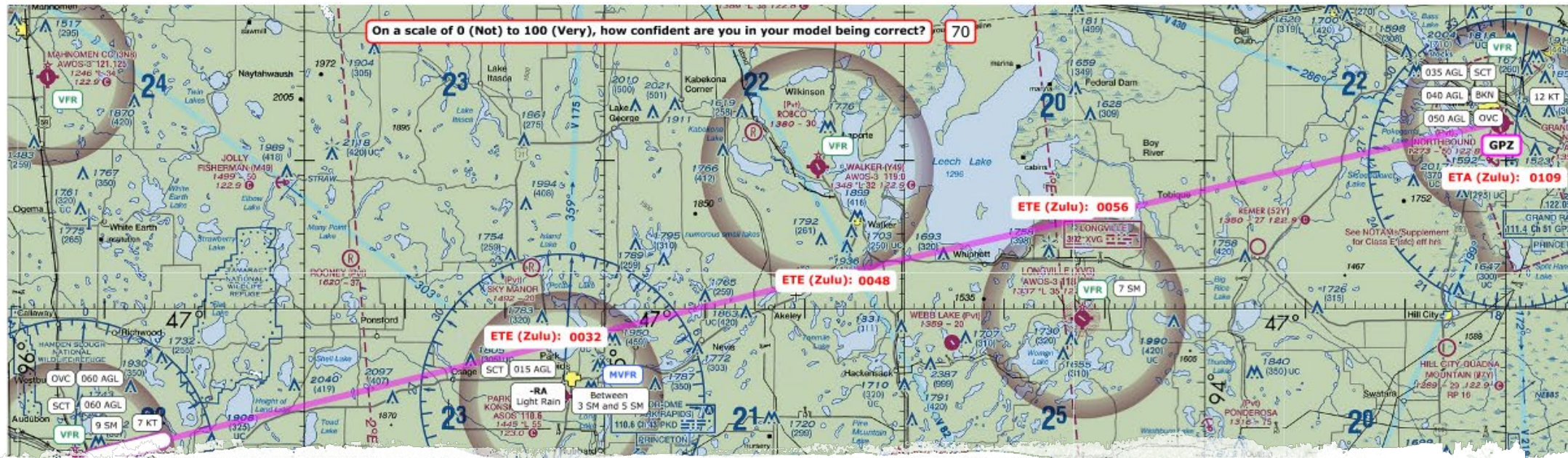
TS
Thunderstorms
Turbulence
Tong

Visibility (SM)

1 SM	6 SM	Less than 1 SM
2 SM	7 SM	Less than 3 SM
3 SM	8 SM	Between 3 SM and 5 SM
4 SM	9 SM	Greater than 10 SM
5 SM	10 SM	

Winds

Calm	4 KT	9 KT	614 KT
10 KT	15 KT	20 KT	25 KT
30 KT	35 KT	40 KT	45 KT
50 KT	55 KT	60 KT	65 KT
70 KT	75 KT	80 KT	85 KT
90 KT	95 KT	100 KT	105 KT
120 KT	130 KT	140 KT	150 KT



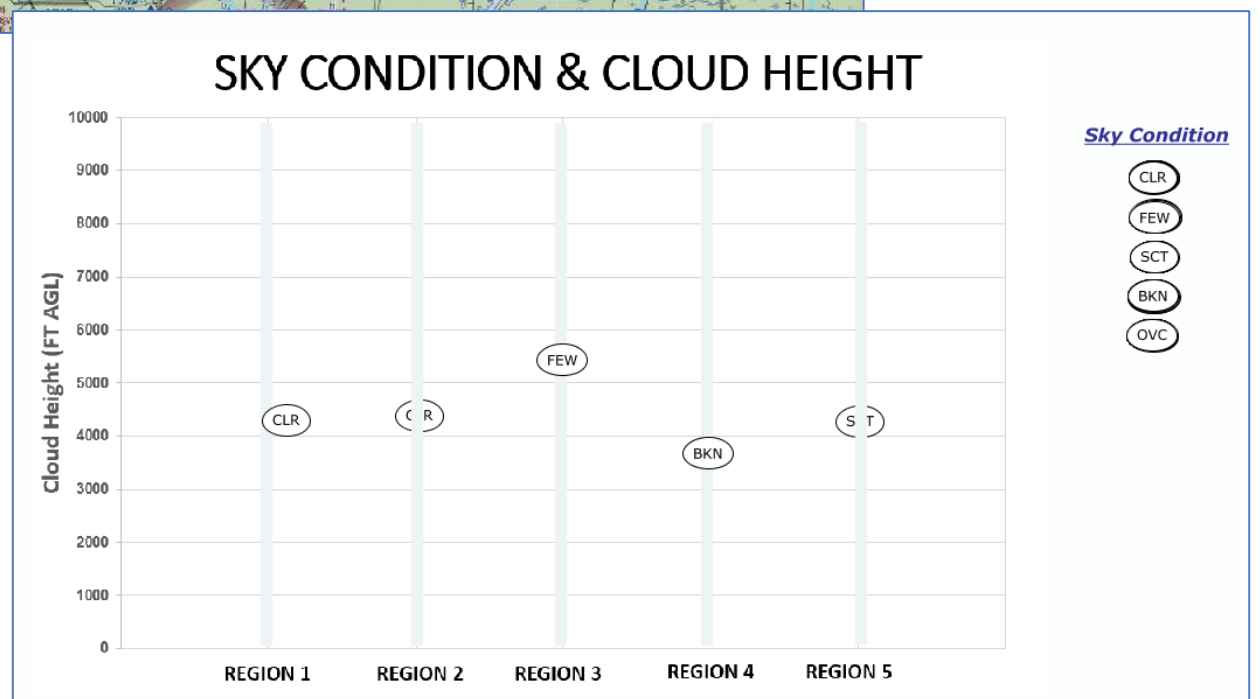
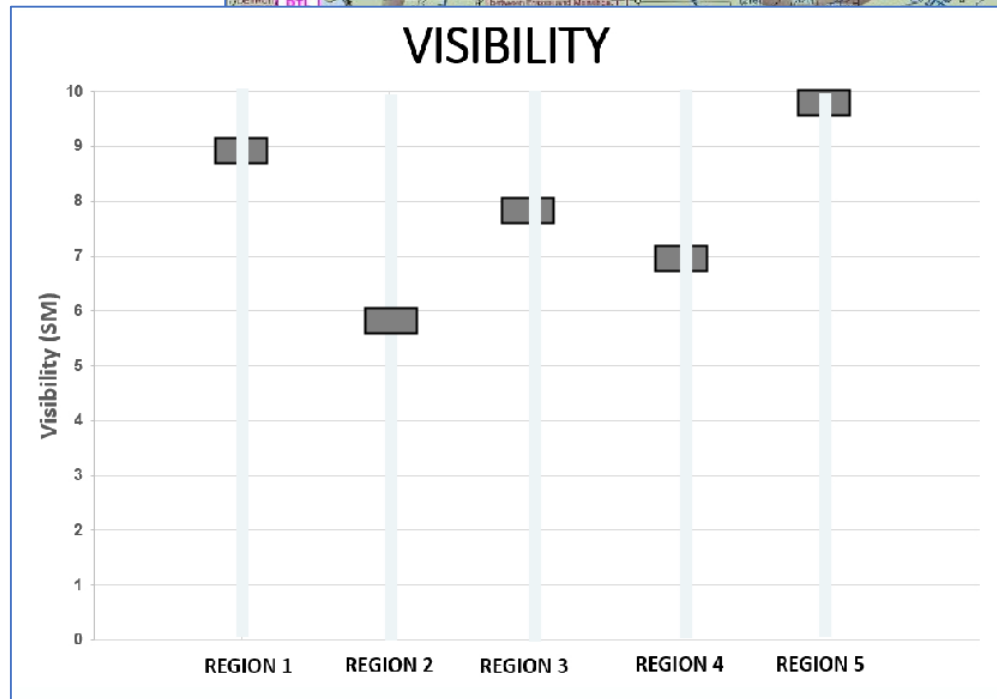
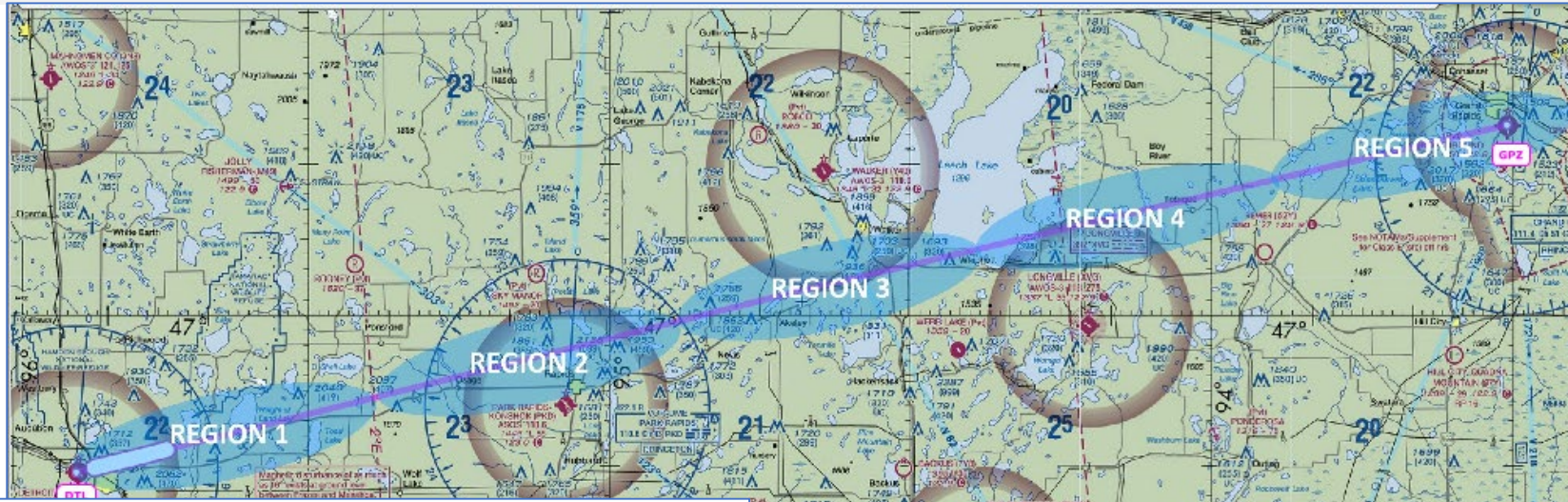
Software: IHMC CmapTools

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**

Mental Model Measure: Cloud Heights & Visibility





RESULTS

Preflight Results: Products Accessed

		Private n = 24	Private w/ Instrument n = 20	Commercial w/ Instrument n = 20	CFI/CFII n = 20	Total n = 84
	n products	M (SD)	M (SD)	M (SD)	M (SD)	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)

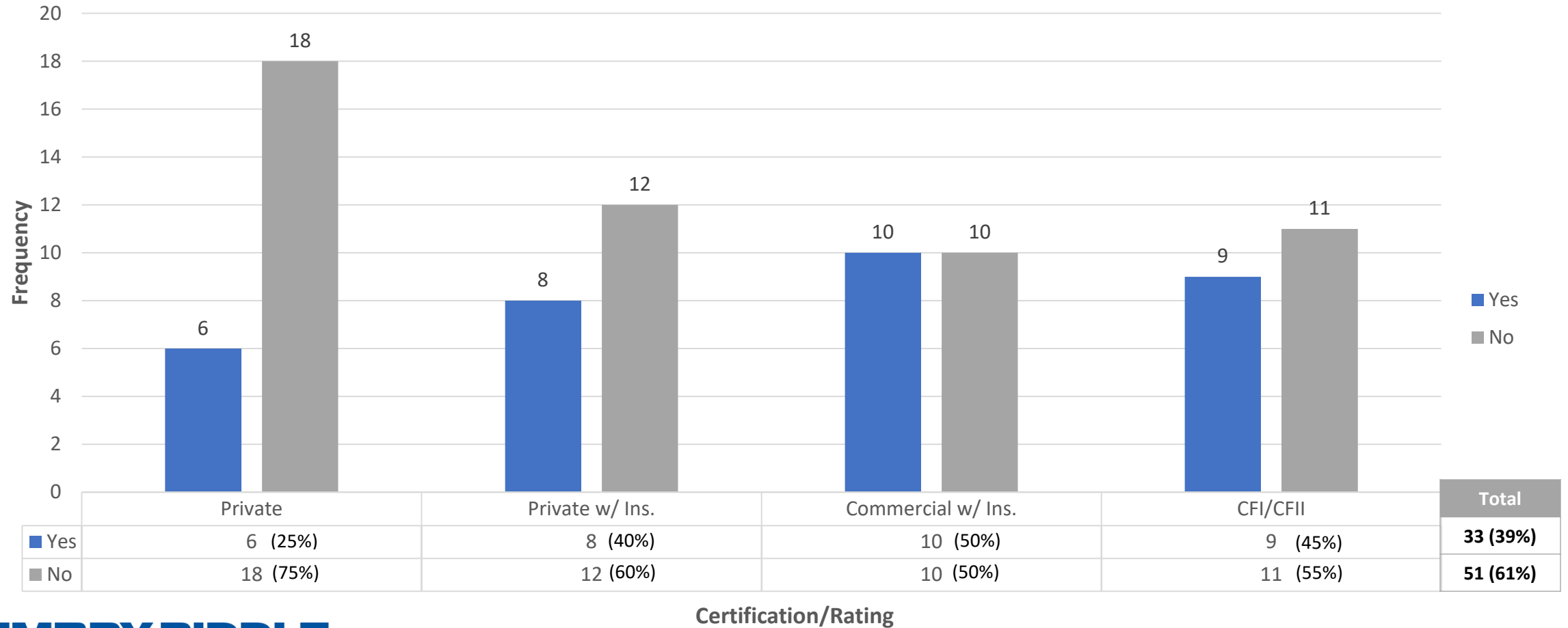
- **Private accessed significantly *less products* than private w/ instrument, $F(3, 71.79) = 3.81, p = .013$, partial eta squared = .13**
- No sig. difference between other ratings

Products Accessed	f (n = 84)
Observation	
METAR	82
RADAR	57
Satellite Images	35
Analysis	
CVA	39
Surface Analysis	25
Forecast	
TAF	51
Area Forecast (<i>Discontinued</i>)	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.*

Correct ETA Frequency



Mental Model Results: Spatial Weather Recall

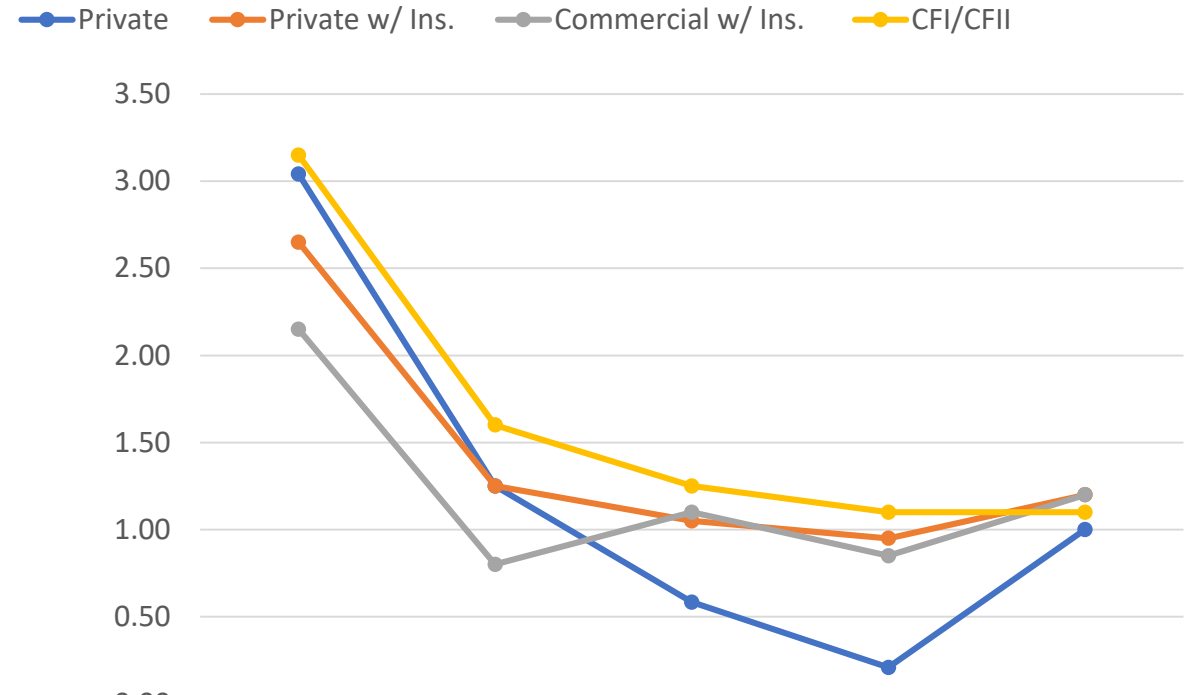
Pilot Certification Main Effect:

- **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)

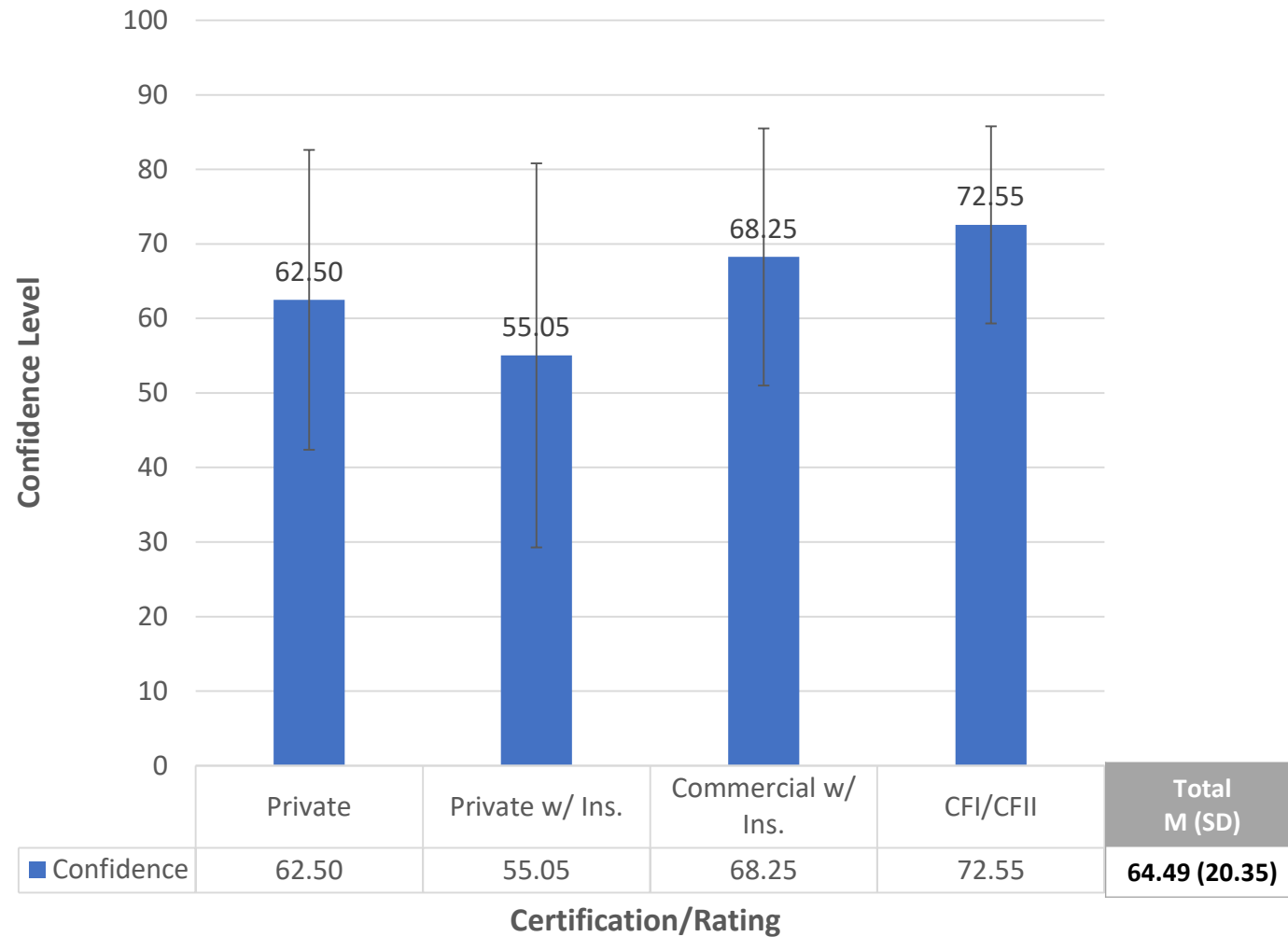
Mental Model Results: Confidence

- **Private w/ instrument pilots had *sig. less confidence* on their mental model being correct than CFI/CFII, $p = .034$**
- No other sig. differences occurred.

Correlation:

- 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***.

Mental Model Correct Confidence

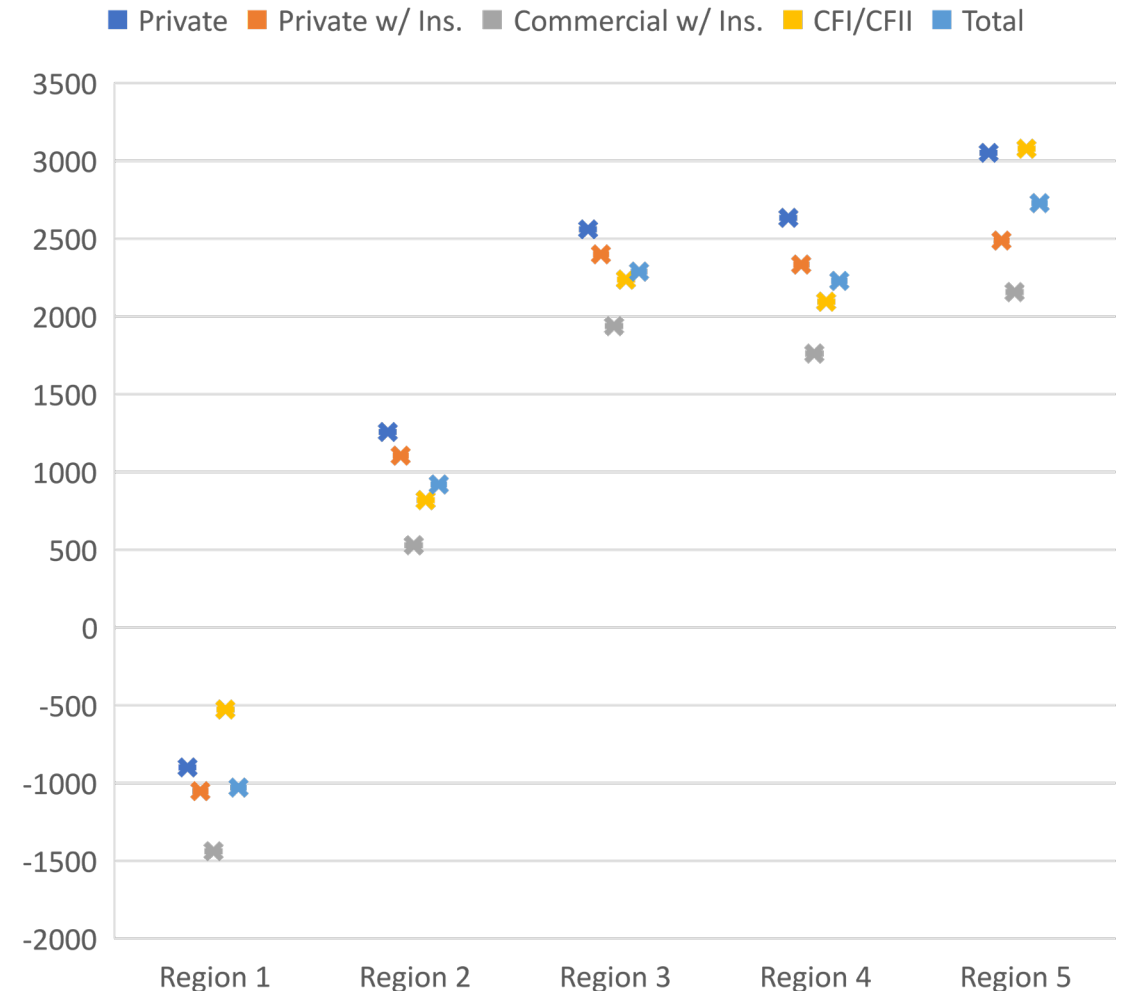


Mental Model Results: Cloud Height

Frequency of Estimated Ceiling Correct by Region

	Private <i>n</i> = 24	Private w/ Instrument <i>n</i> = 20	Commercial w/ Instrument <i>n</i> = 20	CFI/CFII <i>n</i> = 20	Total <i>n</i> = 84
	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>
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

Ceiling Delta Average by Region

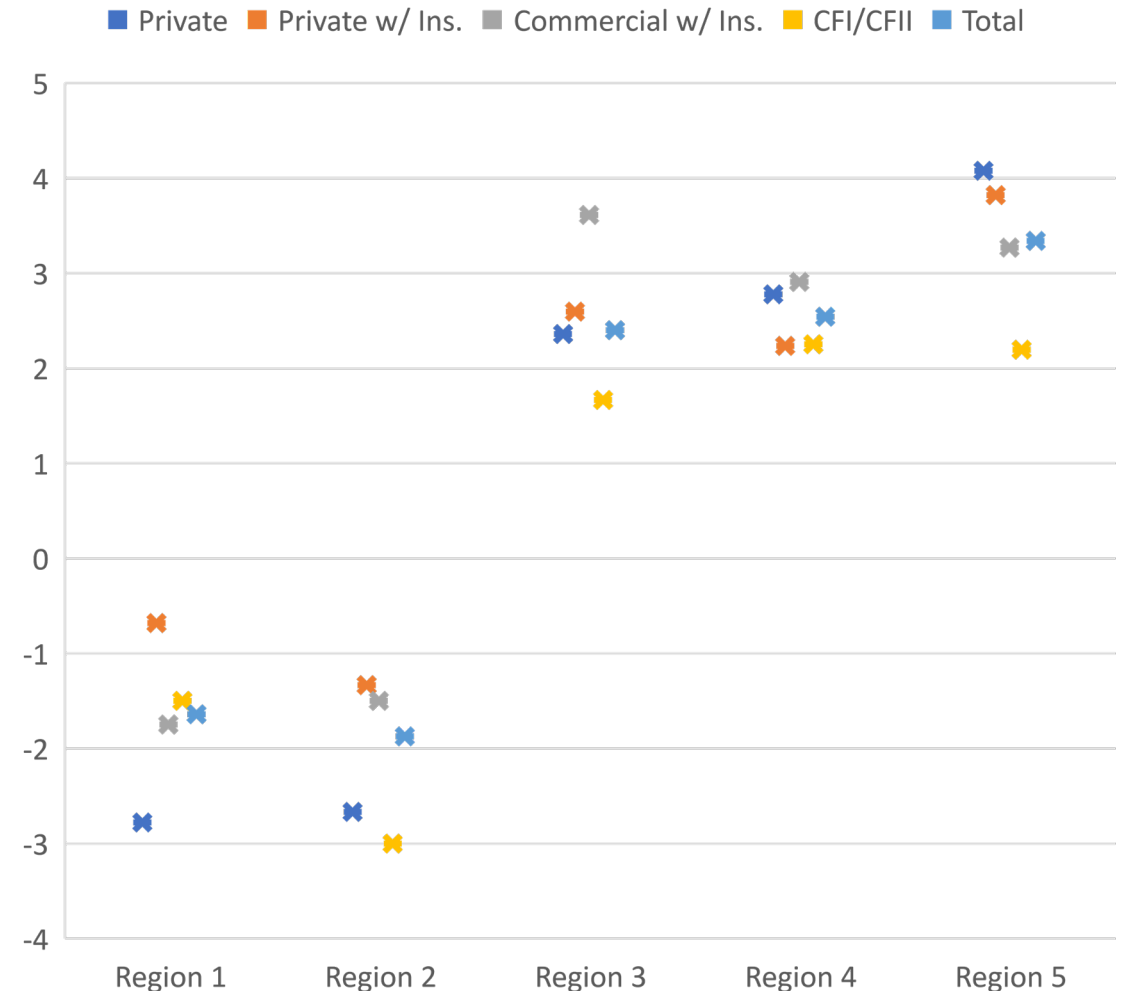


Mental Model Results: Visibility

Frequency of Estimated Visibility Correct by Region

	Private <i>n</i> = 24	Private w/ Instrument <i>n</i> = 20	Commercial w/ Instrument <i>n</i> = 20	CFI/CFII <i>n</i> = 20	Total <i>n</i> = 84
	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>	<i>f</i>
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

Visibility Delta Average by Region

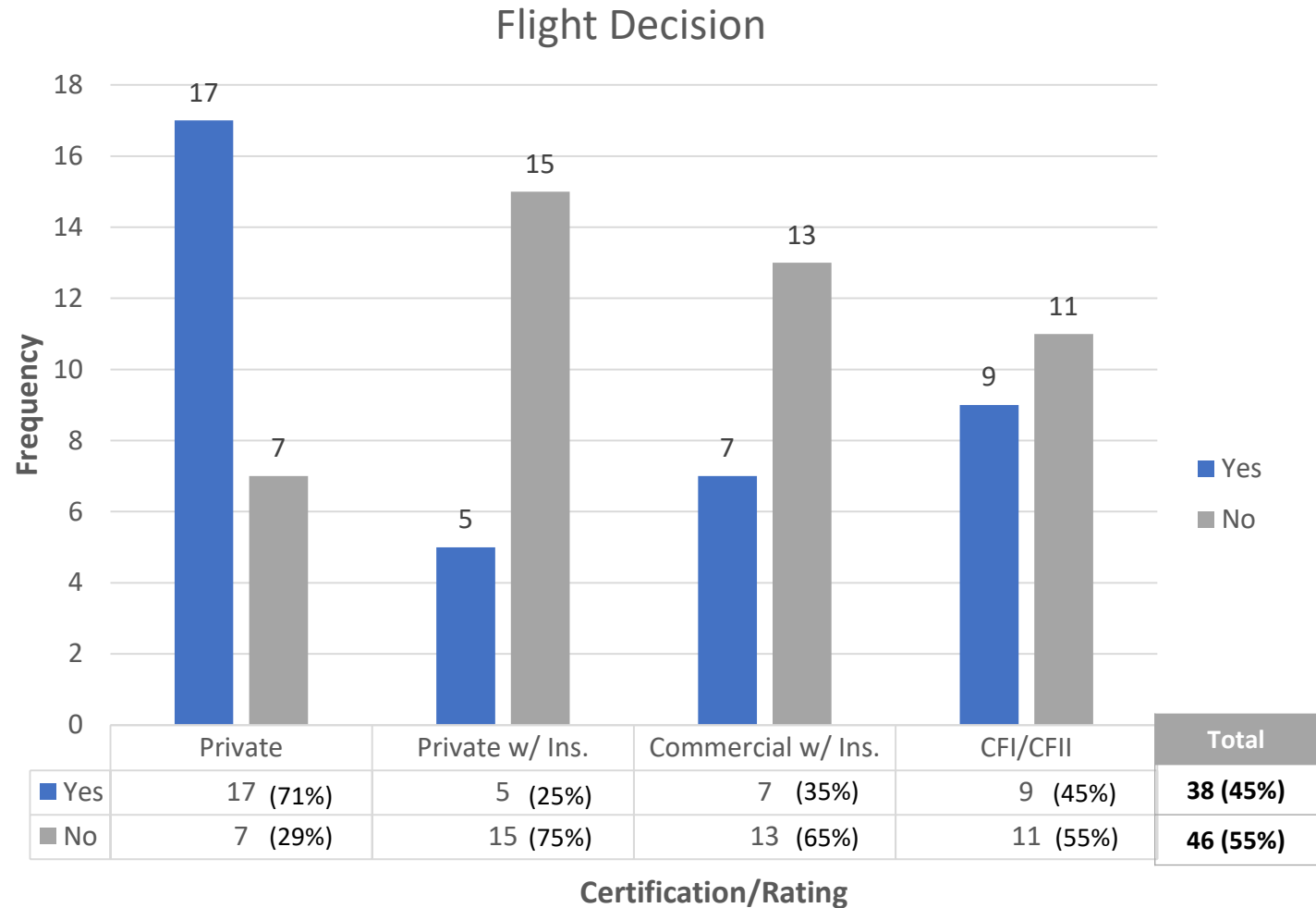


Flight Decision Results: Go or No Go?

- **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.

Correlation:

- 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.



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).

Summary continued

- Furthermore, pilots **may not be**:
 - 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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