

Friends and Partners in Aviation Weather (FPAW)

# Weather Technology in the Cockpit (WTIC) - Uncertainty/Probabilistic Information in the Cockpit Projects



Gary Pokodner

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# WTIC - Overview

- WTIC program is tasked to develop recommendations for a Part 121/135 and a Part 91 minimum weather service (MinWxSvc)
  - ✦ Assessing if probabilistic or uncertainty information in the cockpit reduces or resolves operational shortfalls
  - ✦ Evaluating rendering options and impacts
    - Rendering recommendations part of MinWxSvc
  - ✦ Applications for Part 121/135 different than Part 91
    - Efficiency benefits versus safety benefits

# WTIC – Motivation for Research

- Uncertainty information is interpreted differently in the cockpit than by traffic managers
  - ✦ Supports strategic and tactical decisions
  - ✦ Workload
  - ✦ Displays and presentation variability
  - ✦ Perception of risk and reward
  - ✦ Range of weather background
  - ✦ Training

# WTIC – Motivation for Research

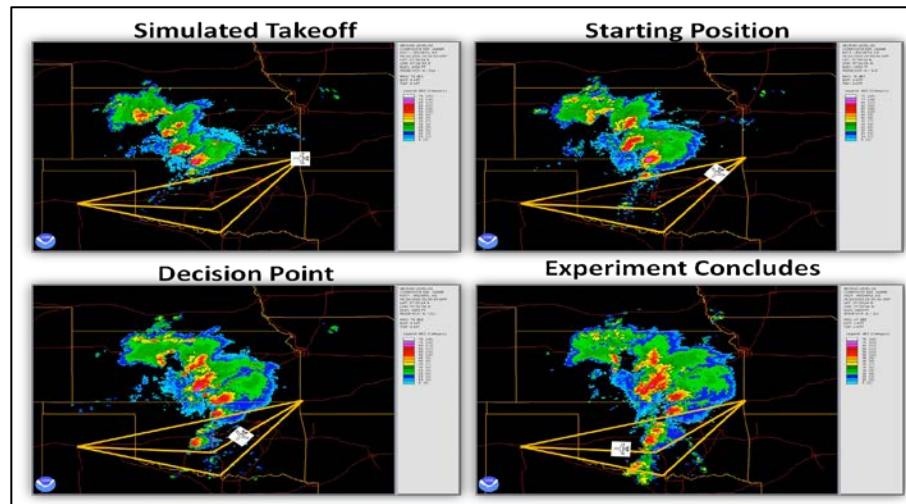
- Other studies on probabilistic/uncertainty information indicate:
  - ✦ Reduces number of decision errors
  - ✦ Lower magnitude of decision errors when they occur
  - ✦ Reduce variability in confidence of MET information
  - ✦ Improved alerting to risks
  - ✦ Potential for improved NAS efficiency (improves trade-off (risk/reward) decision making)

# WTIC – Probabilistic Challenges

- Assessing rendering impacts versus information impacts
- Interpretation of uncertainty information can be impacted by personal experiences
  - ✦ Demonstrations typically involve short term use of prototypes
  - ✦ Benefits may be short term
- Training can significantly affect impacts

# WTIC – Uncertainty Project Overview

- Flight simulation of GA aircraft flying towards red cell
- One pilot group used current deterministic MET information (current commercial rendering) and one pilot group was given uncertainty information in prototype rendering in addition to current commercial rendering
- Observed impacts of uncertainty information on decision making

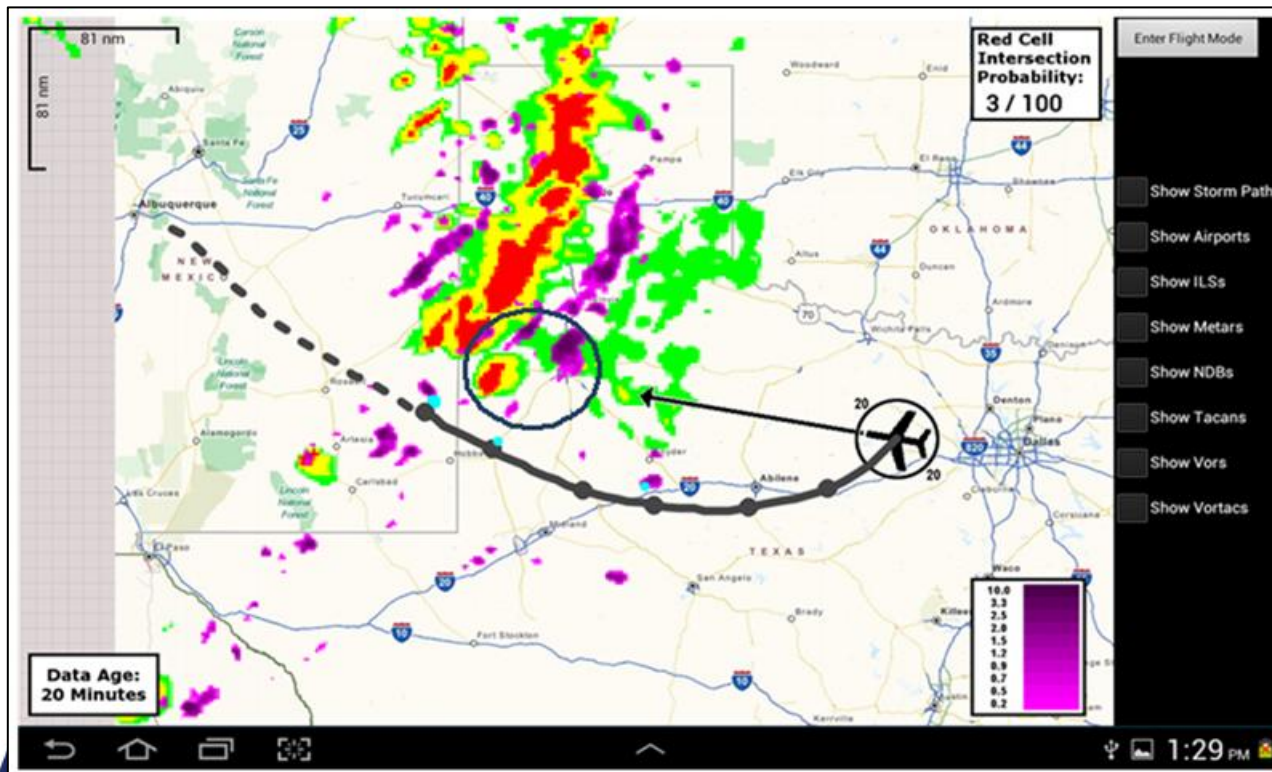


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# WTIC – Uncertainty Prototype Rendering

- Red cell intersection probability presented numerically
- Color shading indicates model consensus



# Uncertainty Information Project Results and Identified Gaps

## Results

| Minimum Distance from any Red Cell* | Display Type  |               |
|-------------------------------------|---------------|---------------|
|                                     | Deterministic | Probabilistic |
| >20 nm                              | 0.00 (0)      | 0.00 (0)      |
| 10-20 nm                            | 0.04 (1)      | 0.13 (3)      |
| 5-10 nm                             | 0.32 (9)      | 0.52 (12)     |
| <0-5 nm                             | 0.54 (15)     | 0.30 (7)      |
| 0 nm (penetration)                  | 0.11 (3)      | 0.04 (1)      |
| Total                               | 1.0 (28)      | 1.0 (23)      |

Proportion and number of pilots in each condition that flew within a certain distance or penetrated at least one red cell

## Uncertainty Study

No pilots complied with the recommended 20nm separation distance from a thunderstorm (red cell)

65% of GA pilots in “deterministic” group and 35% of pilots in “probabilistic” group came within 5nm or less of a red cell

Providing probabilistic weather information influenced pilot behavior to increase distance from red cells

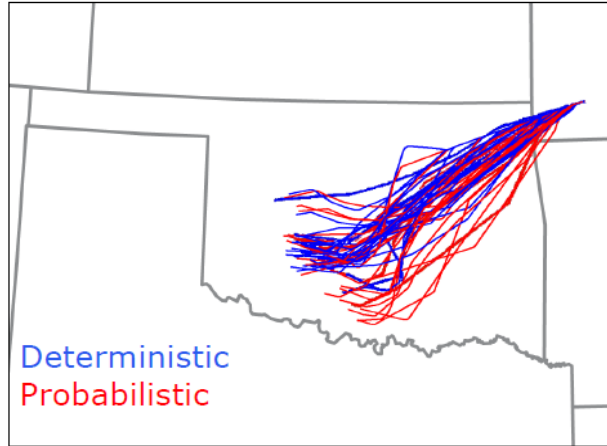




# Uncertainty Information Project Results and Identified Gaps

## Results

- Pilots in the probabilistic condition were more likely to deviate to the south —the safer decision— than pilots in the deterministic condition



Flightpath Divergence



## Uncertainty Study

Flightpaths depicted in Blue were routes taken by those with “deterministic” forecast display

Flightpaths depicted in Red were routes taken by those with “probabilistic” uncertainty forecast display

Pilot simulation group with uncertainty information made safer decisions for red cell avoidance

Providing probabilistic weather information influenced pilot behavior to increase distance from red cells



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# WTIC – Potential Future Research

- Quantify variance in pilot confidence of MET information with uncertainty information provided
- Present forecast weather movement
  - ✦ Determine impacts of weather speed, depth, gaps opening or closing, etc
- Assess different methods of conveying probability (descriptive versus numeric)
- Determine if benefits remain over time
- Assess pilot understanding and use of the information (adverse weather avoidance versus controlled risk taking)
- Impacts of data latency