

General Aviation Cockpit Weather Information System Simulation Studies

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Project Goals

- Develop a Better Understanding of the Use of Data-Linked Weather Information
- Provide Guidance to FAA/Manufacturers on the Use of Data-Linked Weather Information
- Recommend Guidelines for Inclusion in the AIM and ACs

Description

- A Series of Rigorous Investigations Using Piloted Simulation of the Effects of Various Data-Linked Cockpit Weather Information Treatments

Research Triangle Institute (RTI) Completed Experiments

- Use of a Data-Linked Weather Information Display and the Effects on Navigation Decision Making in a Piloted Simulation Study
- The Effects of Ownship Information and NEXRAD Resolution in use of a Weather Information Display

Research Triangle Institute (RTI) Current Experiment

- An Investigation into the Use of NEXRAD Image Looping and the Use of the National Convective Weather Forecast Product on a Moving Map Display for General Aviation

First RTI Experiment

June 1999 to August 2000

**Investigate the use of a Data-Linked Weather
Information Display and the Effects on
Navigation Decision Making in a Piloted
Simulation Study**

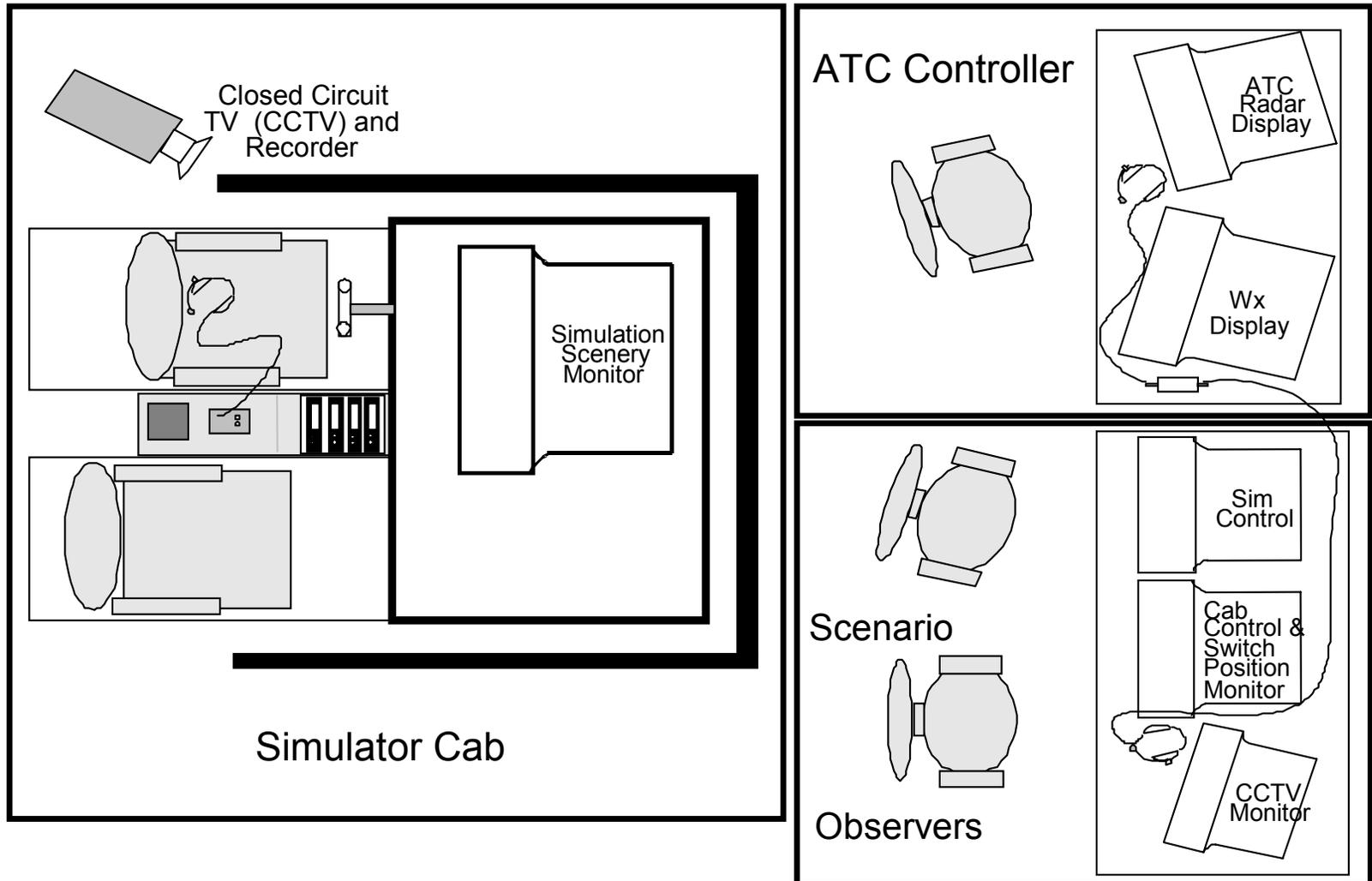
Objective & Hypothesis

- ***Objective:*** To investigate the potential for misuse of weather information, and thus provide guidance to the FAA
- ***Hypothesis:*** Delayed weather information datalinked to a cockpit display may lead to navigation decision errors

Experiment Design

- Two groups of pilots, 12 with a datalinked weather display and 12 without a weather display
- The simulator mission consisted of a two-leg mercy flight with convective weather along the route
- All subjects were current Instrument Flight Rules (IFR) qualified pilots
- Primary data collected consisted of weather related navigation decisions.

RTI Simulation Hardware Configuration



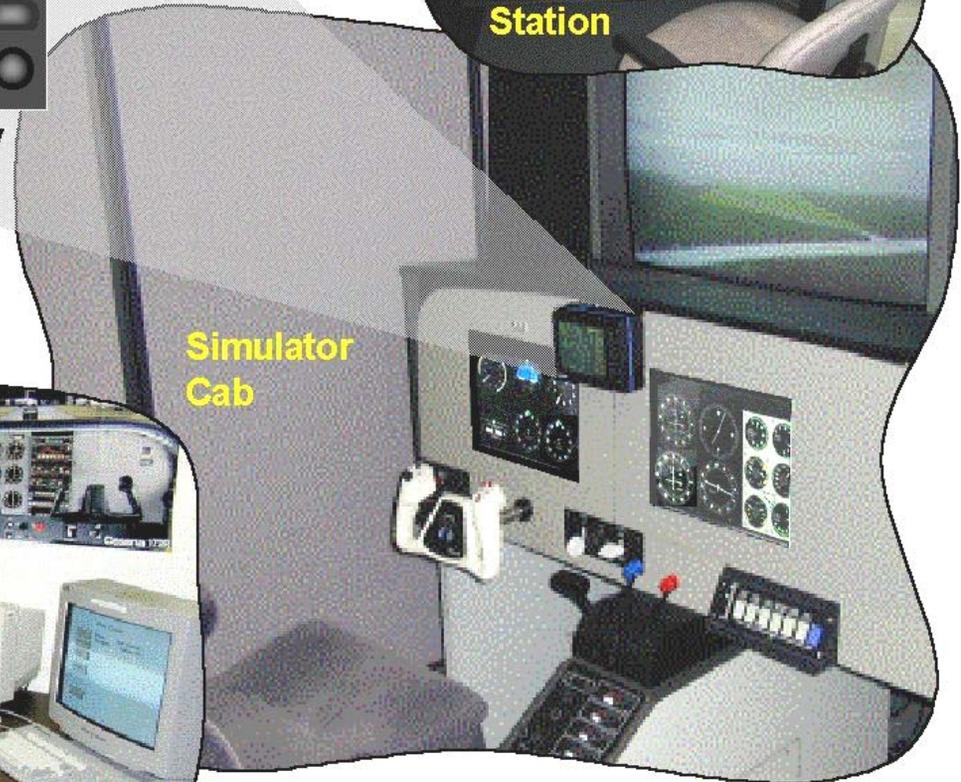
RTI Cockpit Research Facility



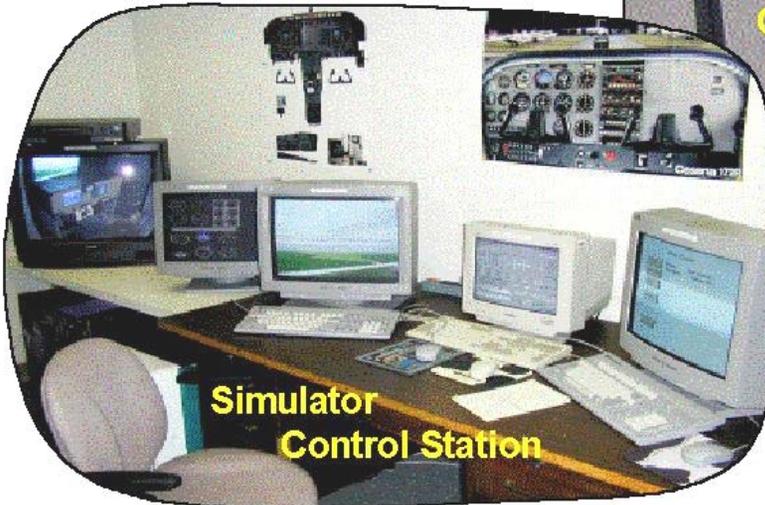
Weather Display



Air Traffic Control Station

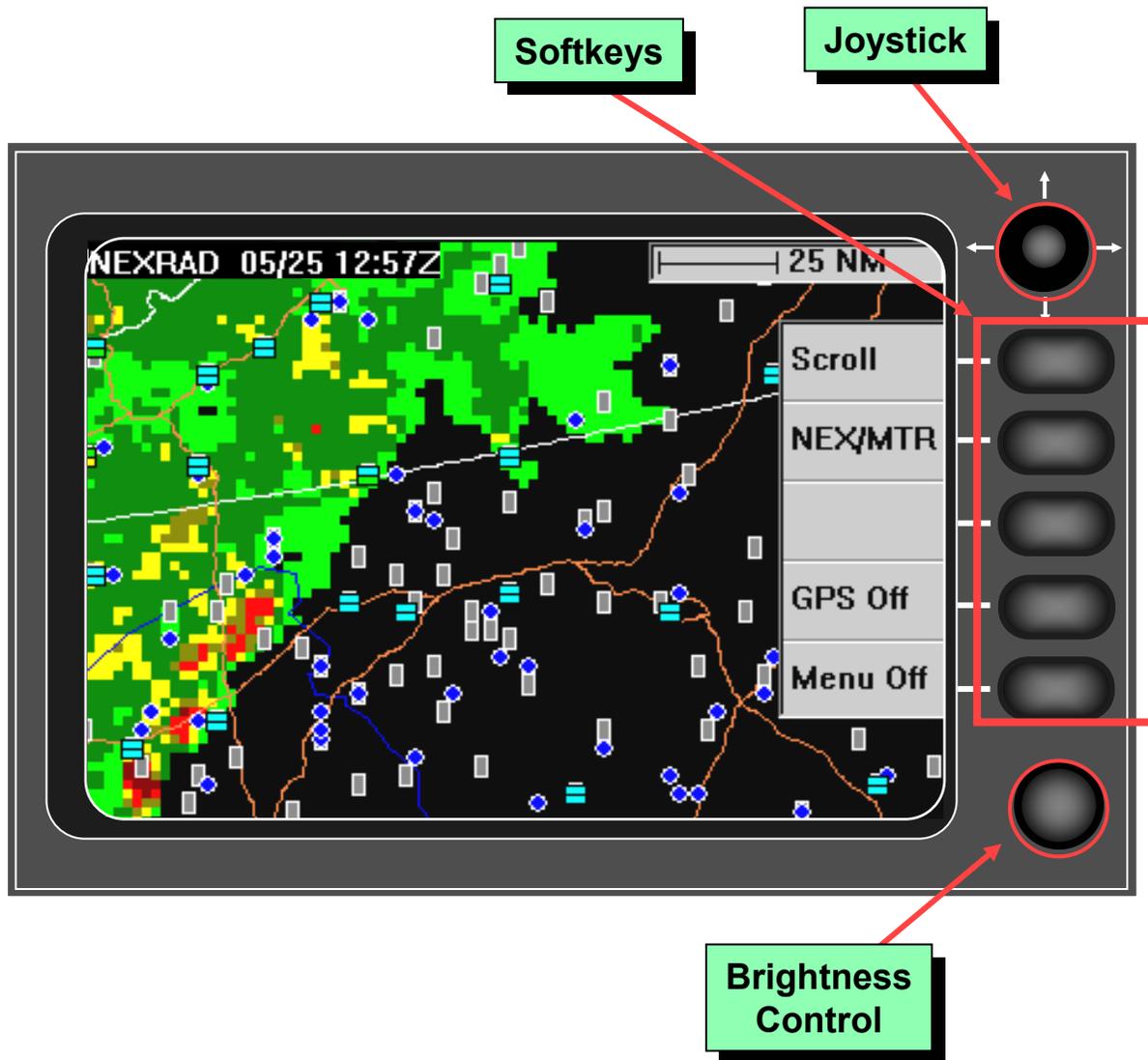


Simulator Cab

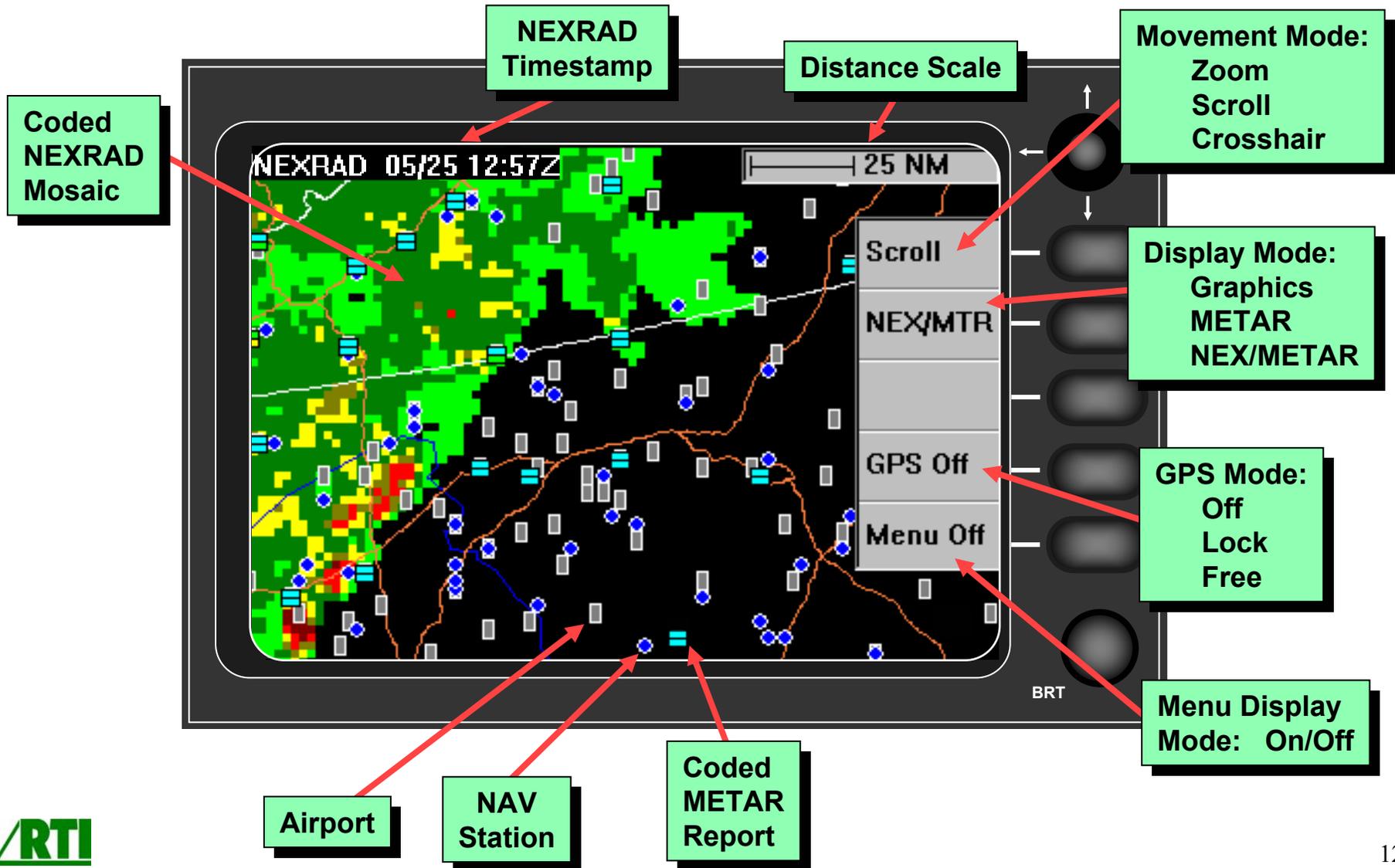


Simulator Control Station

Datalinked Weather Display Configuration



Datalinked Weather Display Screen Layout



Mission Scenario

Take-off from Newport News

Pick-up medicine at Richmond

Encounters thunderstorm that prevents
landing at Richmond (decision 1)

Divert or waved off from Richmond

Continue flight to Wallops Island with medicine.

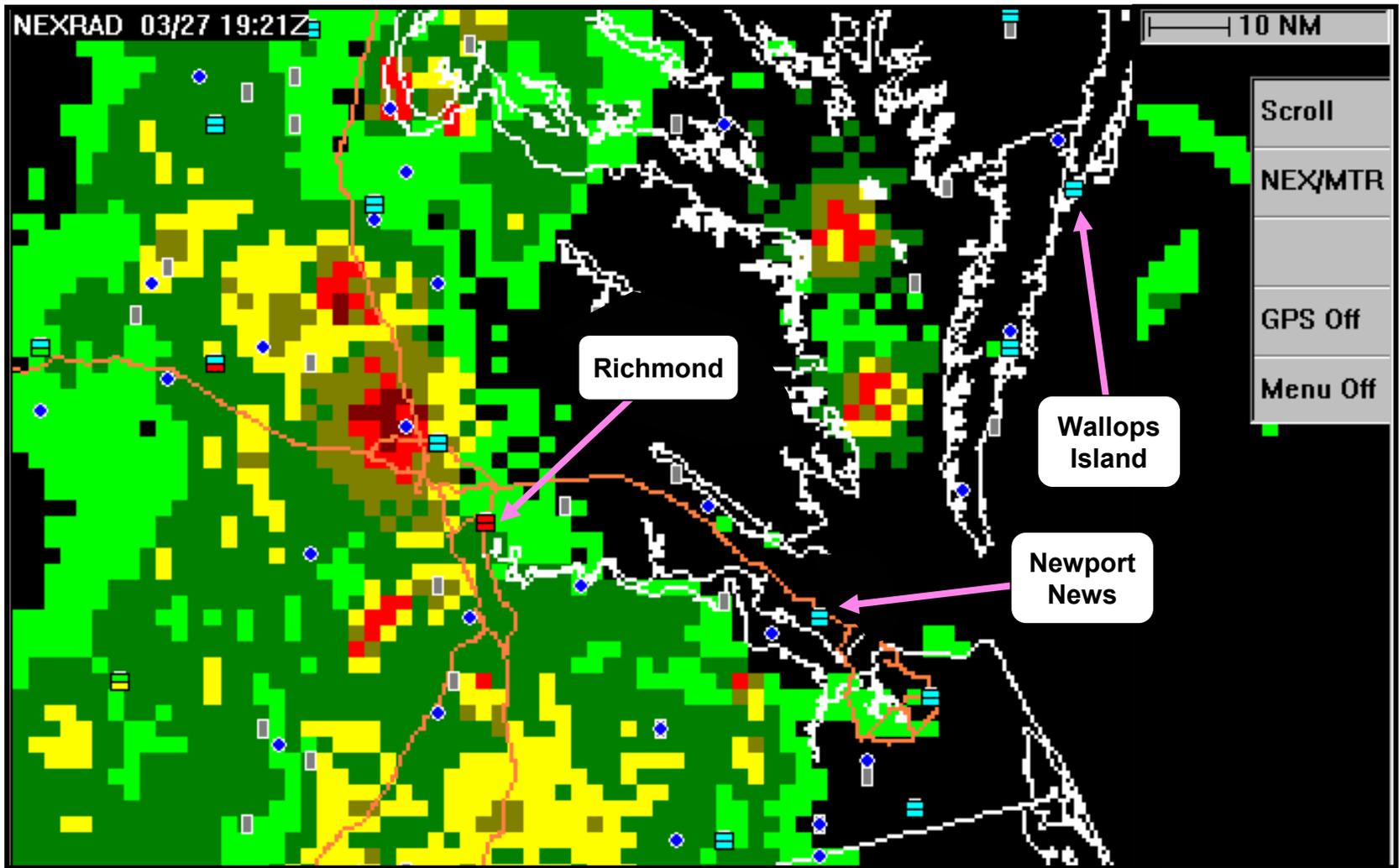
Encounters thunderstorms
enroute to Wallops (decision 2)

Lands successfully at Wallops Island Airport

Experiment Procedure

1. Pilot given Risk Aversion and Weather Knowledge tests
2. Pilot briefed on mission, simulator and weather display
3. Pilot provided instruction and practice in the simulator
4. Pilot planned flight (charts, weather reports provided)
5. Pilot performed the mission, data was collected
6. Pilot completed Immediate Reaction Questionnaire
7. Pilot participated in structured interview, data was collected
8. Pilot completed open-ended questionnaire

(each experiment session took approximately 5 hours)



Conclusions

- The weather display system used in this study did not improve pilot decision making
 - Situational awareness increased but at a cost of higher workload
 - Pilots were unable to easily perceive their proximity to potentially hazardous weather conditions
 - Pilots had difficulty determining storm movement
 - Display caused less reliance on other weather sources

Recommendations

- Provide the following features
 - Ownship information symbology
 - Direction and rate of hazardous weather
 - Intuitive NEXRAD image age information
 - Provide METAR code translation
 - Develop training curriculum
 - Emphasize that a weather display not to be used for navigation

Second RTI Experiment

September 2000 to April 2001

Investigate the Effects of Ownership
Information and NEXRAD Resolution in
the use of a Weather Information Display

Objective & Hypothesis

- **Objectives:** Explore the relationship between delayed uplinked weather information and aircraft ownship. Explore the effect of differing sizes of NEXRAD cell size on pilot judgement.
- **Hypothesis:** There is a potential for misuse of delayed weather information superimposed onto a moving map display with aircraft ownship.

Additionally, weather display resolution is an integral element of weather situational awareness, and has a significant effect on pilot judgement.

Comparisons of follow-on experiment to previous baseline experiment

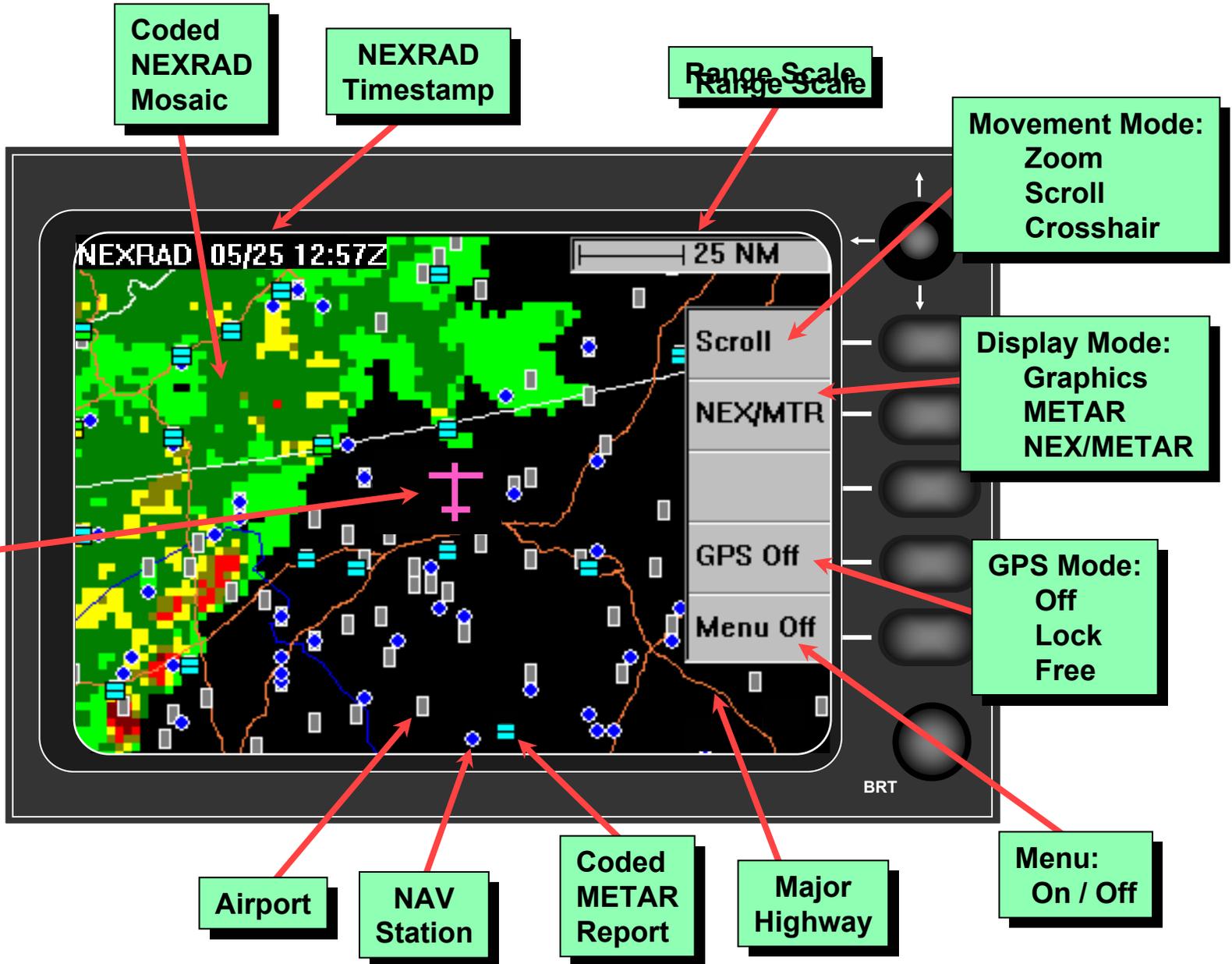
Experiment similarities:

- Identical facilities
- Similar subject pilot selection process
- Similar data collection (expanded)
- Identical materials and procedures
- Similar data analysis (expanded)

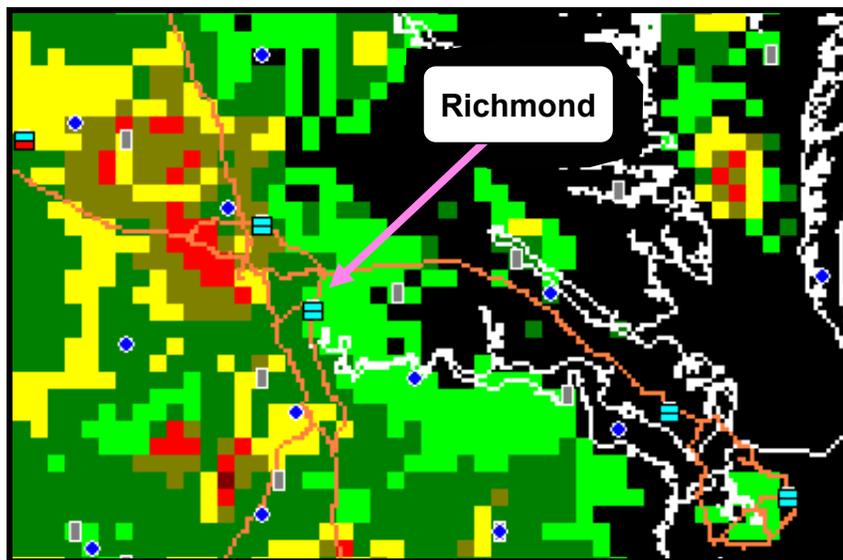
Experiment differences:

- Addition of ownship symbology to weather display
- One group of 12 pilots used 4 km NEXRAD cells
- The other group of 12 pilots used 8 km NEXRAD cells

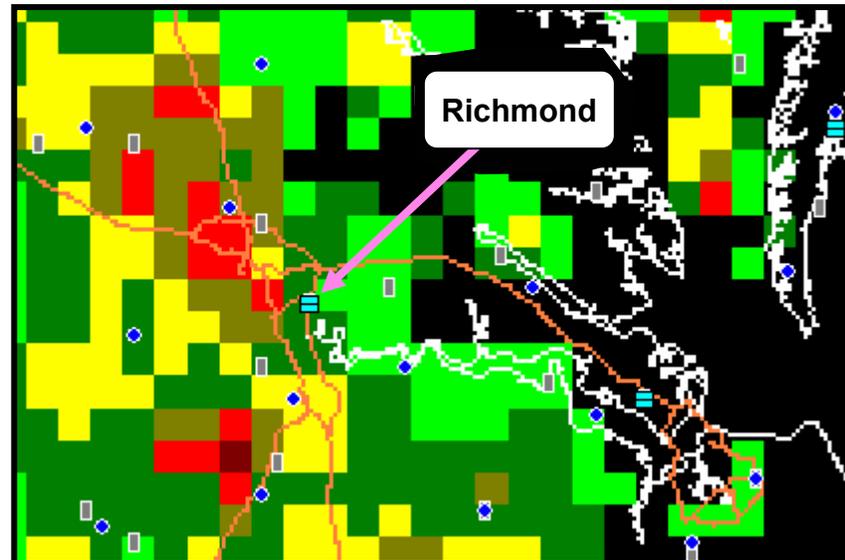
Datalinked Weather Display with Addition of Ownship Symbology



Comparison of Small and large NEXRAD cells



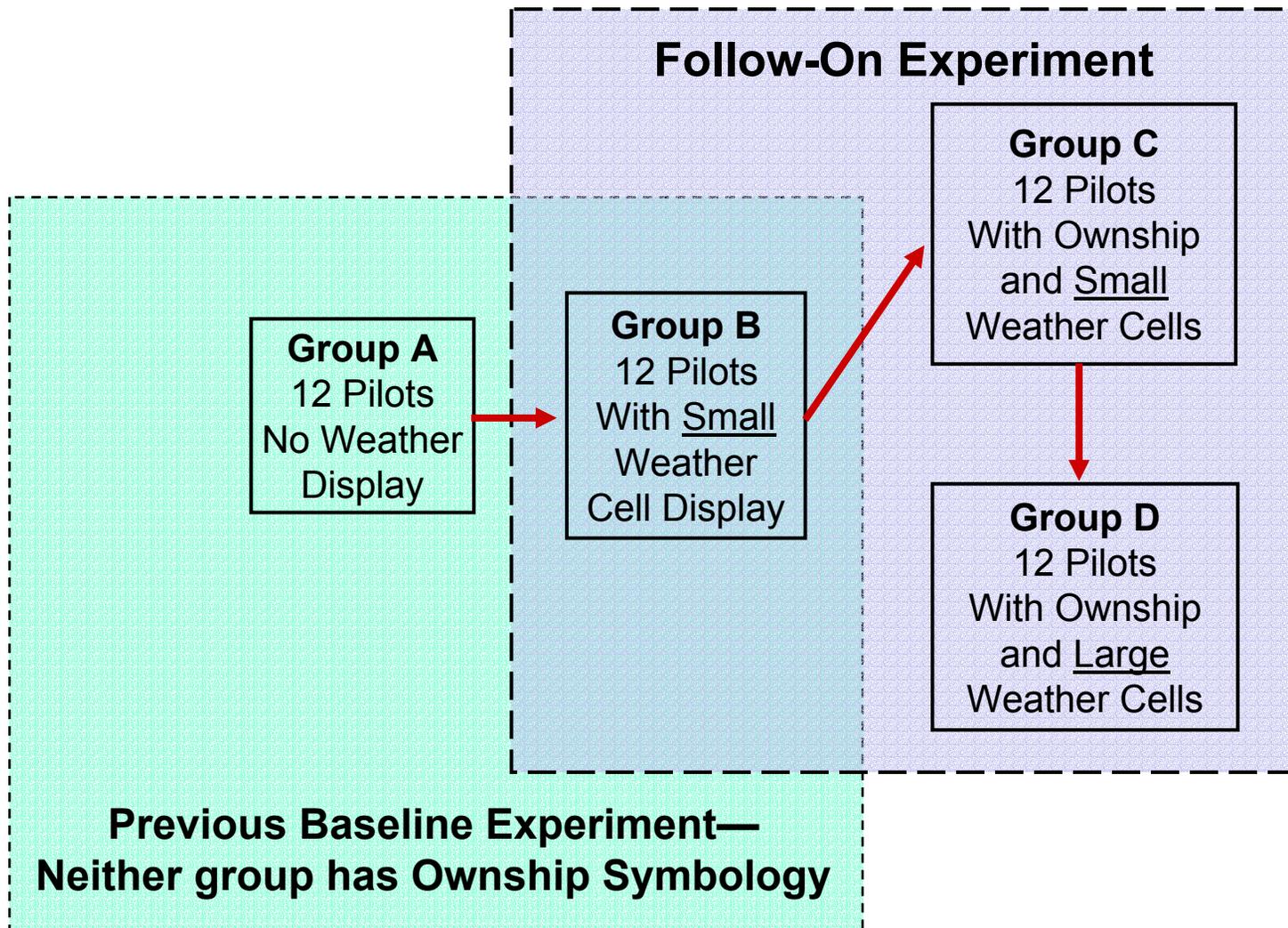
1914Z NEXRAD Image
Small Cells (4 km sides)



1914Z NEXRAD Image
Large Cells (8 km sides)

(both maps cover identical geographical areas)

Relationship to Previous Baseline Experiment



(red arrows denote statistical comparisons)

Mission Scenario

(identical to baseline experiment)

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Pick-up medicine at Richmond

Encounters thunderstorm that prevents
landing at Richmond (decision 1)

Divert or waved off from Richmond

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Encounters thunderstorms
enroute to Wallops (decision 2)

Lands successfully at Wallops Island Airport

Experiment Procedure

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(each experiment session took approximately 5 hours)

Data Collection

The primary data collected consisted of weather related navigation decisions...

— good or poor, based on objective criteria

... and the weather information gathering methods used to arrive at those decisions.

**— weather services used, and how the pilot
integrated the information**

Conclusions

- Datalinked weather display increased situational awareness of hazardous weather
- Introduction of ownship symbology did not increase number of good decisions, but did decrease workload
- Introduction of larger NEXRAD cells did have a positive effect on decision making
- Use of datalinked weather display compelled some pilots to forgo use of corroborating weather sources
- Textual METAR teletype codes were difficult to decipher in high workload situations
- Pilots questioned validity of METAR data due to age
- Larger NEXRAD cells contributed to stimulus area effect

Recommendations

- Provide ownership information symbology
- Provide more effective means of distance determination
- Provide intuitive NEXRAD image age information
- Train pilots in the use and limitations of datalinked weather displays
- Provide METAR teletype code English translations
- Investigate depiction of direction and rate of hazardous weather movement

Overview of Continuing Research

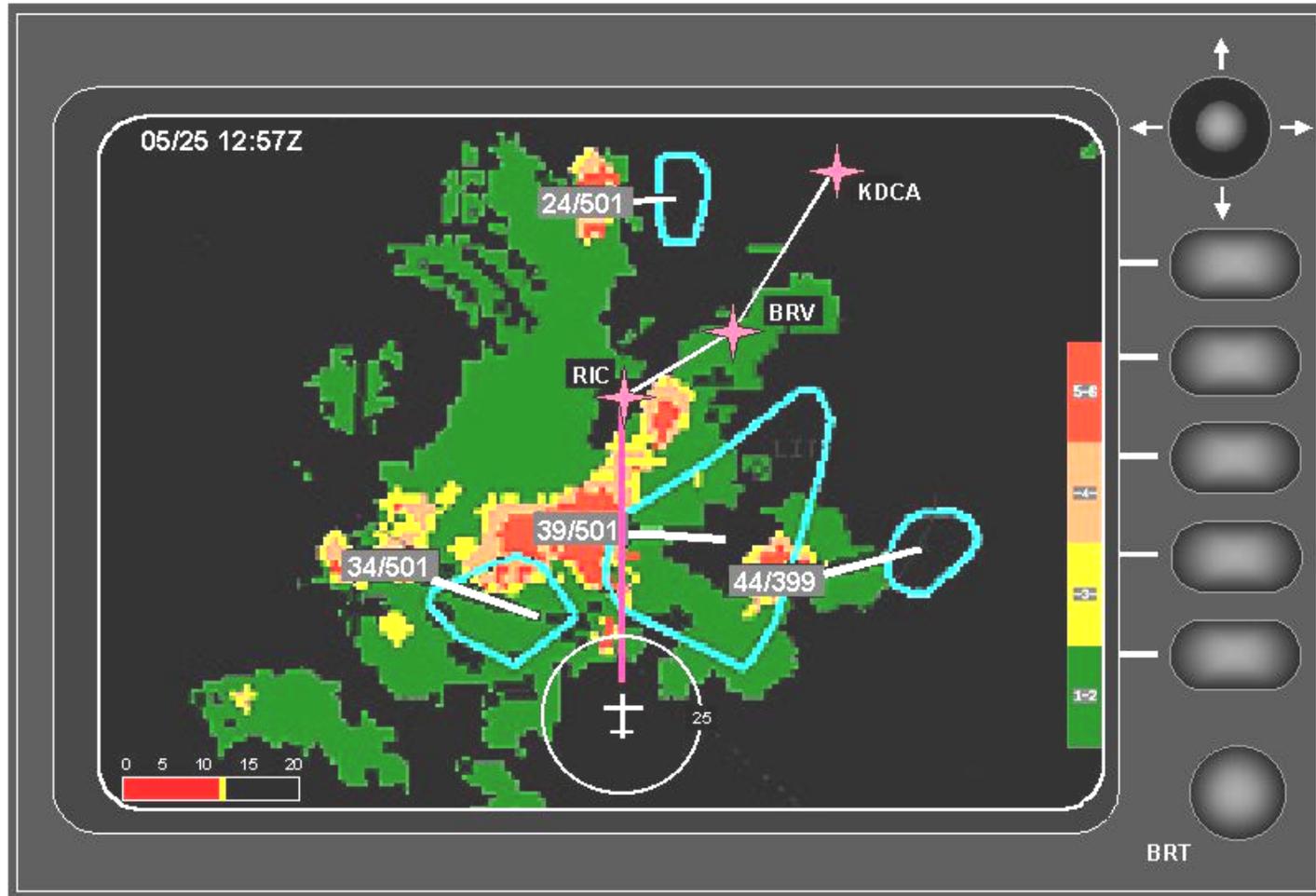
(started May 2001)

An Investigation into the Use of NEXRAD Image Looping and the Use of the National Convective Weather Forecast Product on a Moving Map Display for General Aviation

- Determine the effects of NEXRAD looping on pilot decisions and workload
- Determine the effects of using a nowcast product on pilot decisions and workload

The experiment will be similar in design, procedures, equipment, mission and analysis to the previous two experiments

Datalinked Weather Display with the National Convective Weather Forecast Product



(blue outlined areas indicate one-hour forecast of cell movement)

Some Possible Future Experiments

- Investigation into the use of Data-Linked Weather Information Display with Enhanced Weather Products and Decision Aids during Collaboration with Weather Service Providers (Collaborative Decision-Making Training Issues)
- Investigation of the Effect of Information Search Prompting upon use of Weather Displays in Decision Making.
- Investigation into Workload and Decision-Making Effects of an Integrated Weather and Navigation Display System

QUESTIONS? ;-)