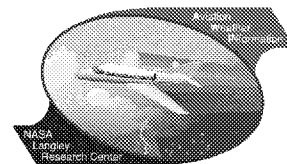
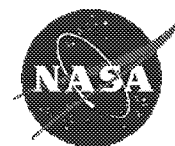


TAMDAR Capabilities Development

June 6, 2001

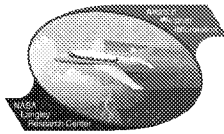


Taumi Daniels

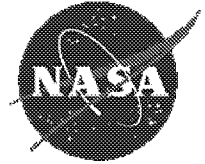
NASA Langley Research Center
Hampton, Virginia

(757) 864-4659

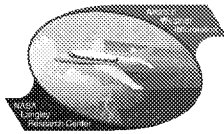
t.s.daniels@larc.nasa.gov



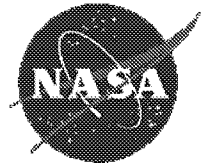
Outline



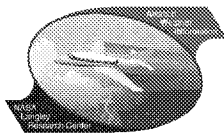
- Goal & Background
- TAMDAR Sensor Development & Testing
- Coverage Analysis
- Related FAA & NOAA Activities
- Fleet Operational Evaluation
- Alternate Method
- Summary



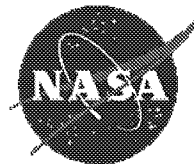
Goal of TAMDAR



"Demonstrate a TAMDAR system capability through a fleet evaluation in the NAS under a FAA, NOAA, NASA, and Industry joint effort."



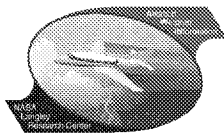
TAMDAR Background



National Aviation Weather Program Council (Federal Coordinator for Meteorology, NASA, FAA, NTSB, NWS, DOD, Department of Agriculture)

- National Aviation Weather Program Strategic Plan, April 1997
- National Aviation Weather Initiatives, January 1999

- Implement data link capabilities for Flight Information Services (FIS)
- Develop and implement multifunctional color cockpit displays incorporating FIS products
- Expand and institutionalize the generation, dissemination, and use of automated **PIREPS** to the full spectrum of the aviation community, including general aviation
- Improve underlying weather forecasting services
- Require, develop, and implement aviation weather-related training packages for users
- Improve aviation weather information telecommunications capabilities for ground-ground dissemination of aviation weather products
- Establish objective standards for characterizing various weather phenomena for national and international use

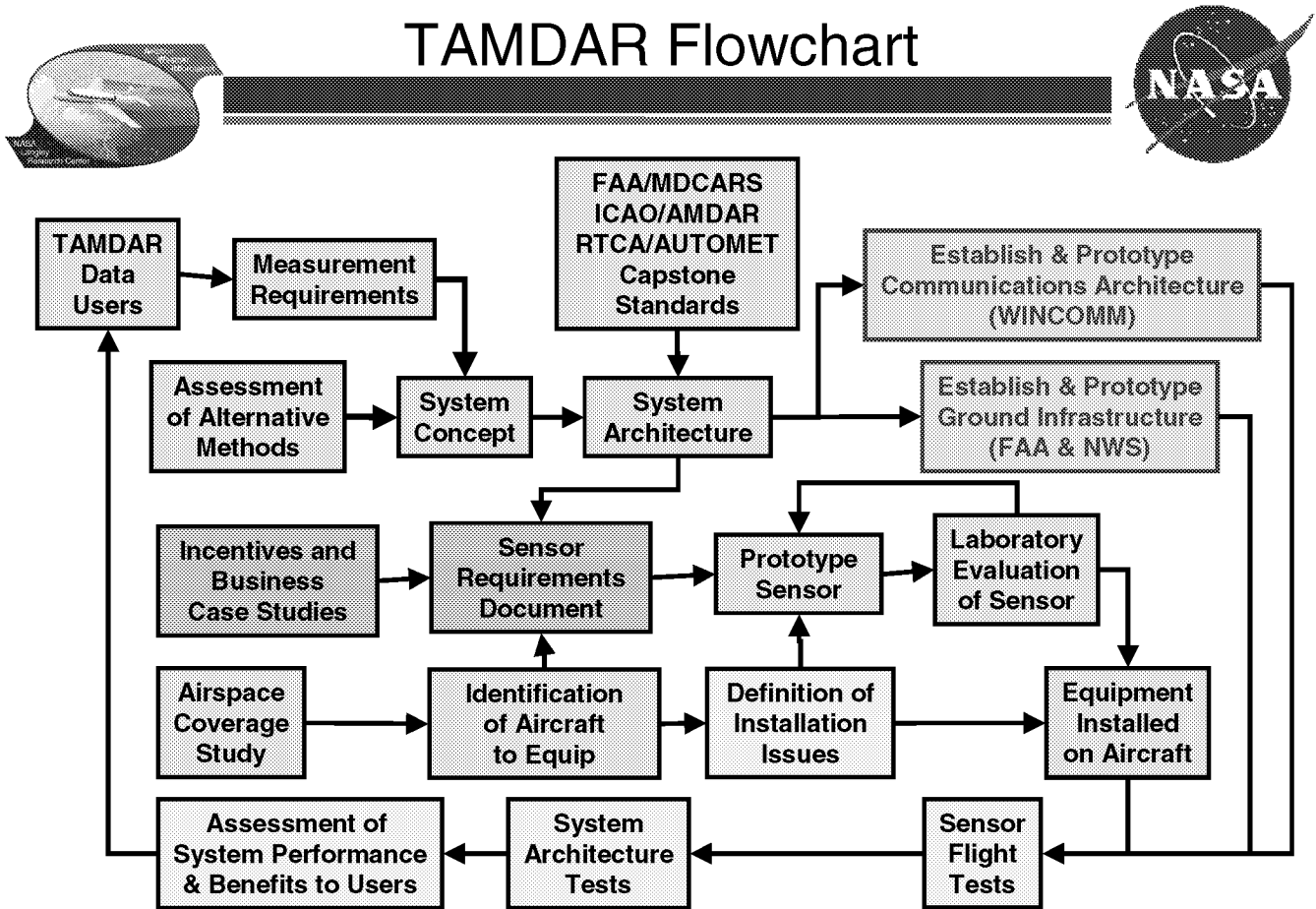


TAMDAR Background

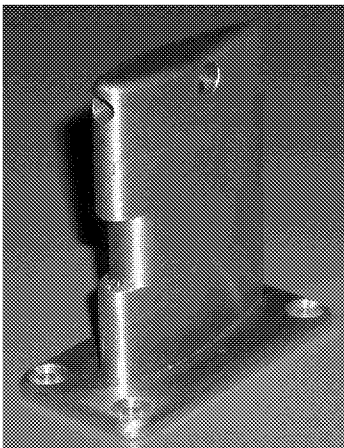
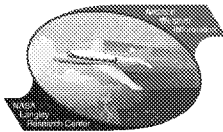
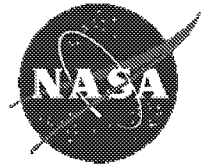


- NavRadio Team Phase I CRA propose low cost electronic pilot report capability
- Transmitter design stymied by lack of frequency allocation; effort focused on sensor
- After many acquisitions, NavRadio ➡ Honeywell, Int.
- Phase II CRA not pursued by Honeywell, Int.
- Effort becomes project under AWIN
- Tri-Agency Team formed to develop concept of operations
- GTRI / ODS task contract in place to complete sensor development
- ARNAV Phase II CRA to deploy sensors and test data link

TAMDAR Flowchart



TAMDAR Sensor



ODS Sensor

Icing
Temperature
Pressure Altitude
Humidity
Magnetic Heading
Eddy Dissipation Rate*
True Airspeed*
Dew point*
Density Altitude*
Winds at Altitude*

*can be computed



Cockpit Display

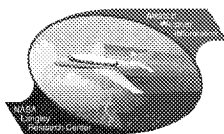


Ground Station

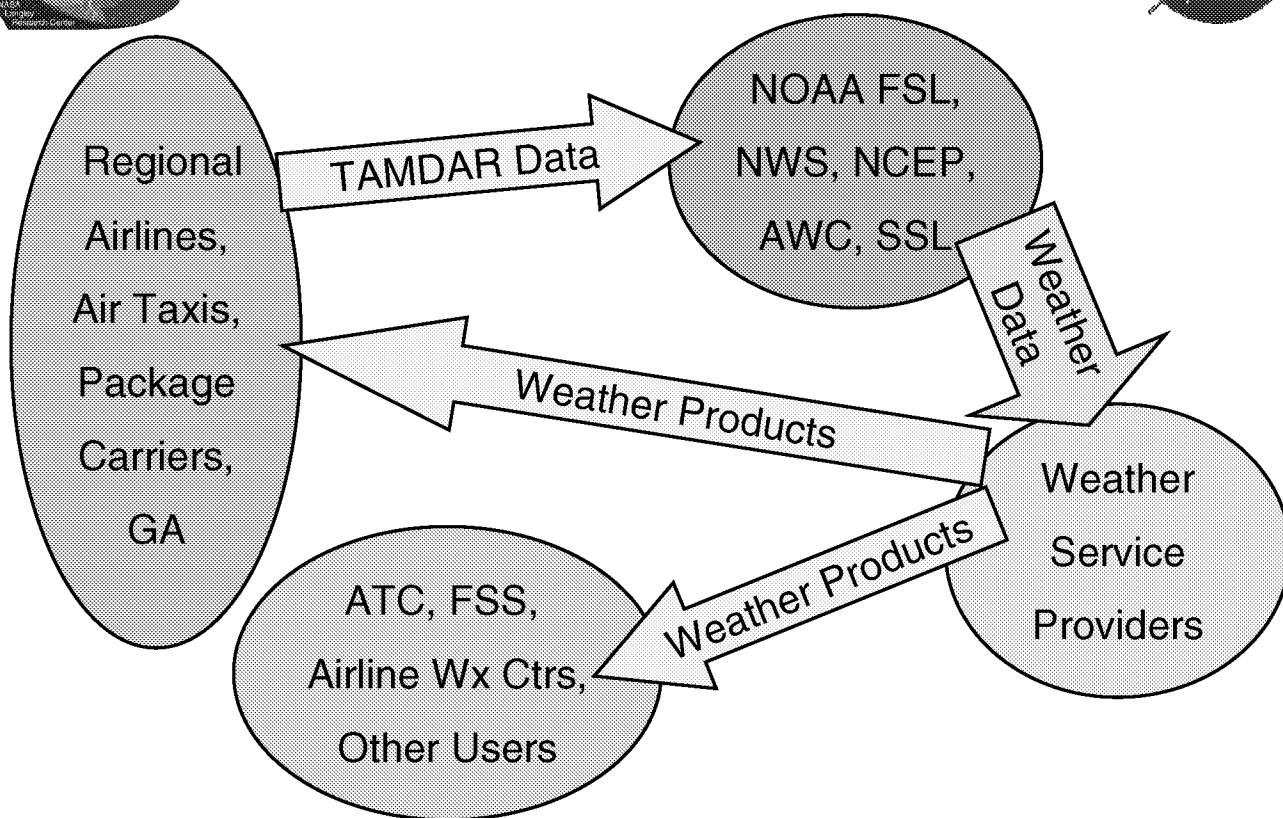
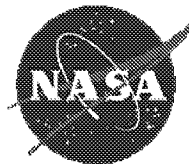


Other Aircraft

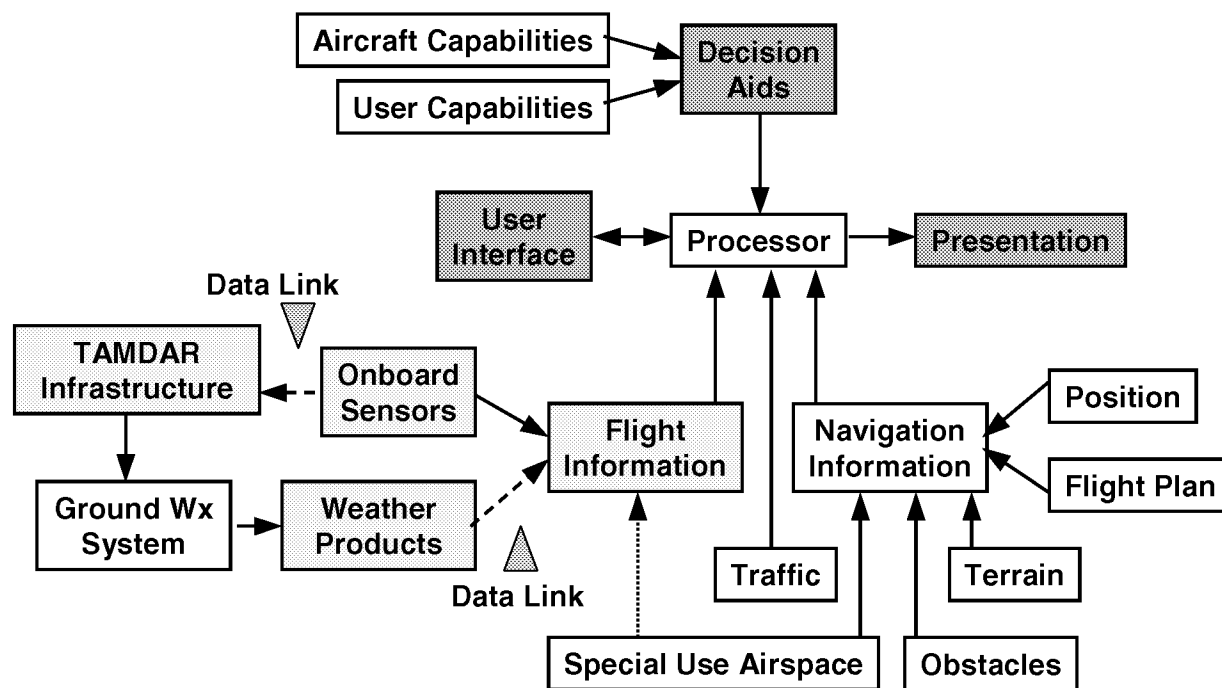
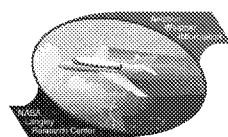
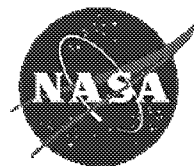
TAMDAR is envisioned to downlink weather data from non-jet aircraft. The weather data will be sent to FSL, FSS, ATC, AWC, and others via a ground-based infrastructure and to other aircraft. New weather products will be generated and uplinked to the cockpit.

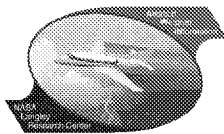


TAMDAR System Concept

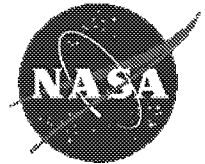


AWIN System

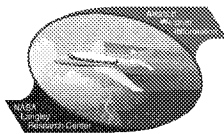




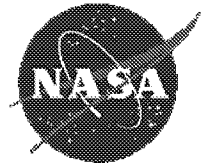
Sensor Development



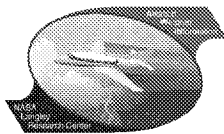
- Task Contract with GTRI and subcontractor ODS
- Subtask 1: Requirements Definition and Design Review
- Subtask 2: Sensor Fabrication
- Subtask 3: Flight test on research aircraft
- Future Tasks: Evaluate flight test results; make design modifications as needed, fabricate additional units; conduct fleet evaluation; evaluate results



Sensor Development



- Current version of sensor ground tested and flight tested
- Next version of sensor currently under development
- Flight test of next version planned for 10-11/01 on-board University of Wyoming B200 atmospheric research aircraft
- Possible flight testing during International Water Project (IHOP) 5-6/02

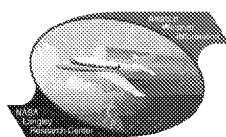
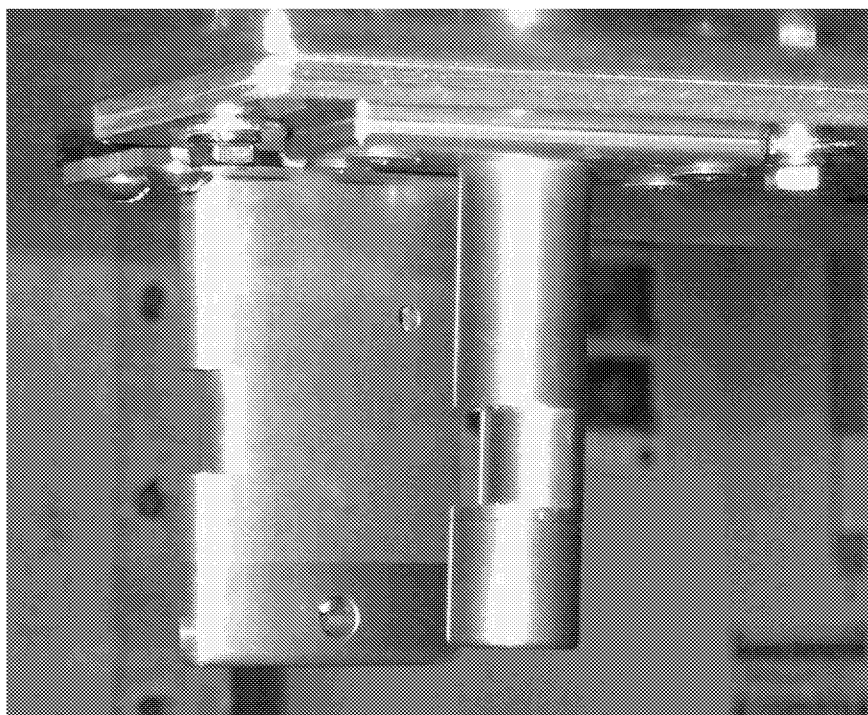
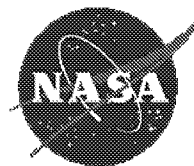


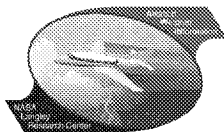
NASA Ground Tests



- Langley 7 x 10 Inch Low Speed Tunnel (5/2001 – 6/2001)
 - Air speed, temperature, pressure comparison
- Langley Test & Dynamics Branch Facilities
 - “Shake and Bake” testing includes temperature, pressure, and vibration
 - Testing to be conducted May – June 2001
- Glenn Icing Research Tunnel Test (3/21 – 3/23)
 - Piggyback on another test
 - ODS also tested Model 1000 Icing Sensor

NASA Ground Tests

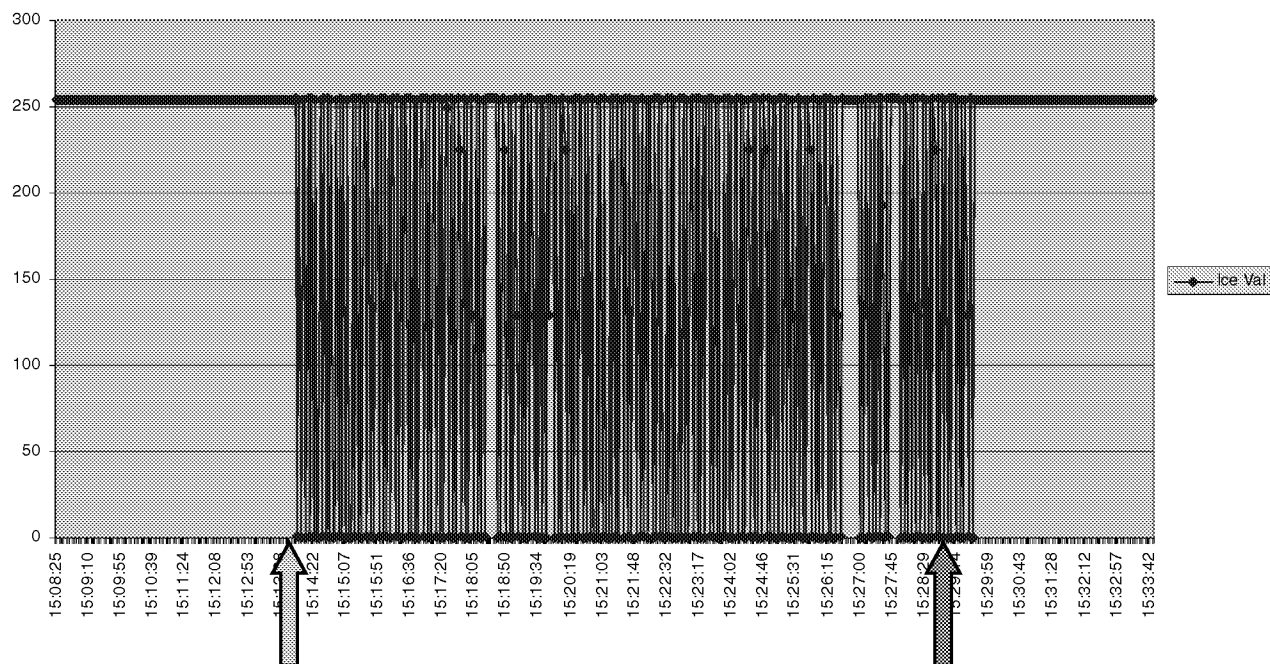




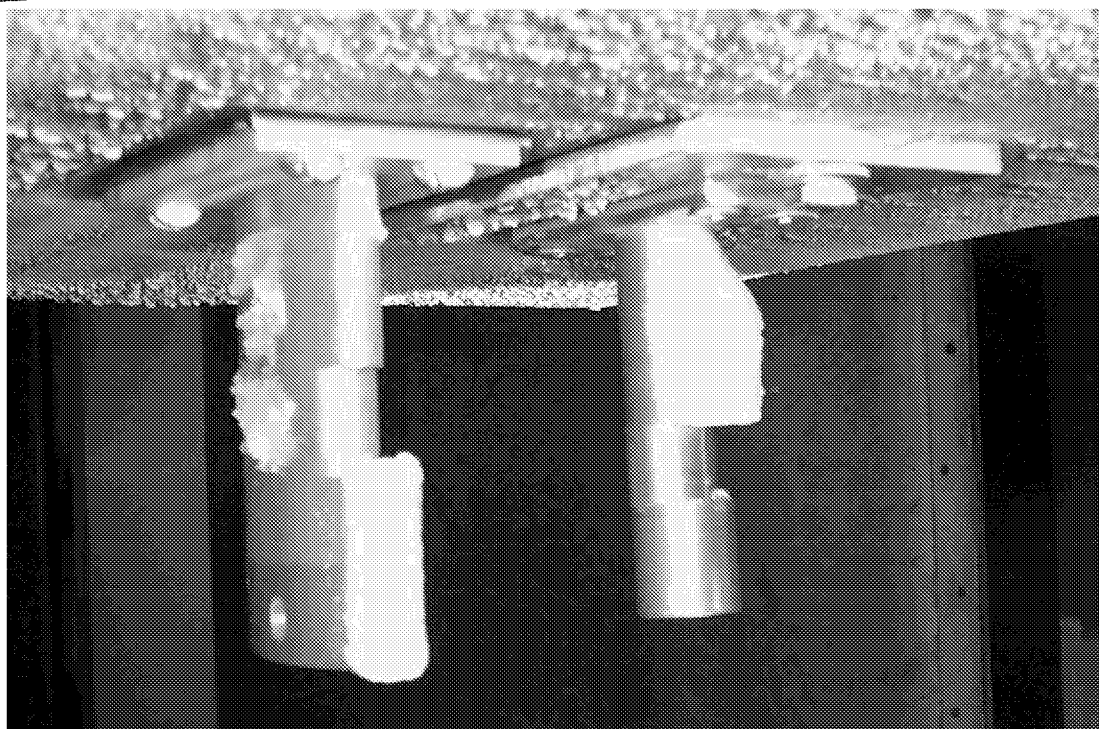
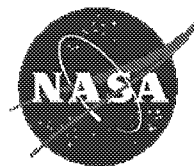
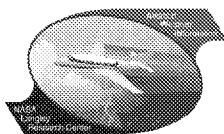
NASA Ground Tests



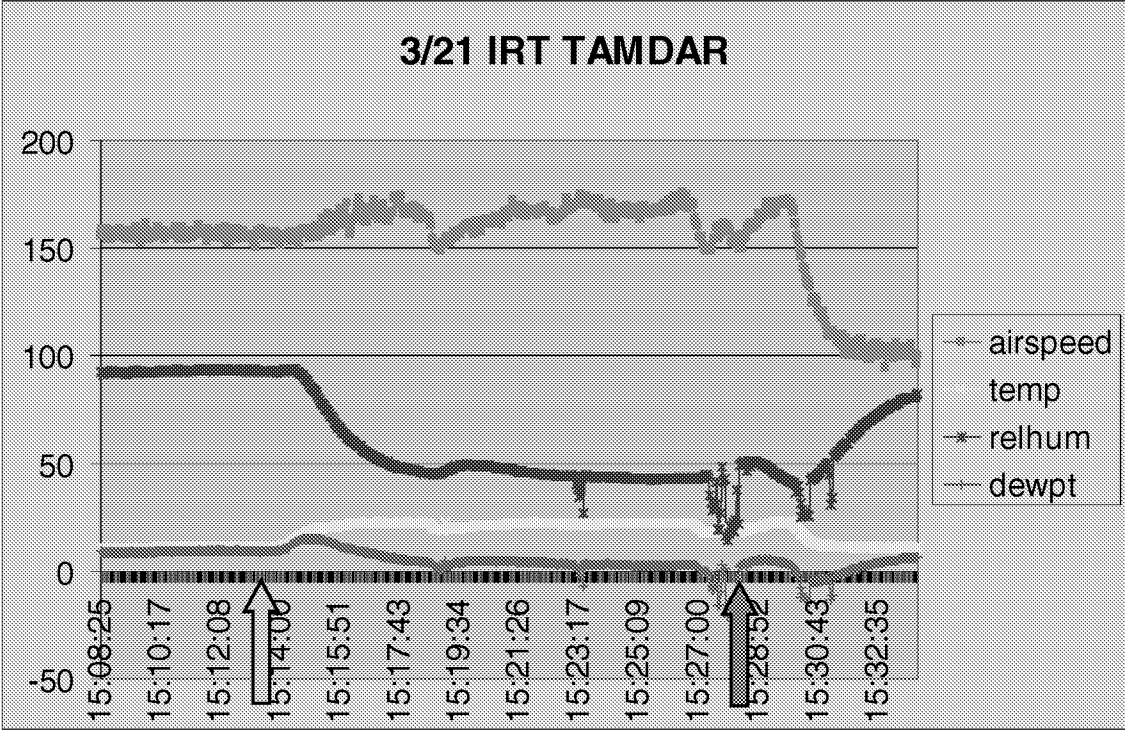
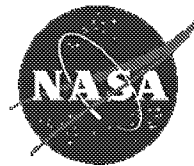
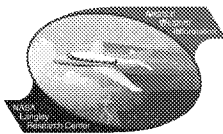
3/21 First Run Icing Response



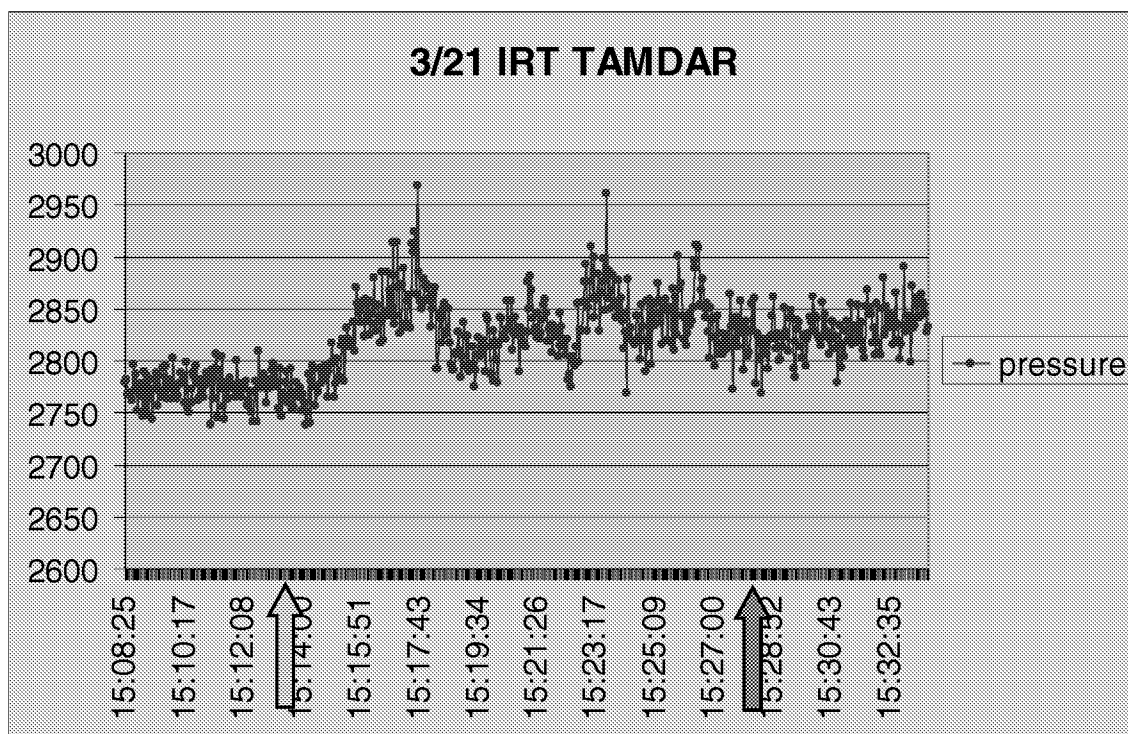
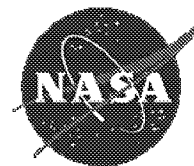
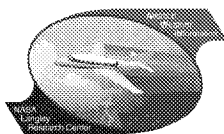
NASA Ground Tests

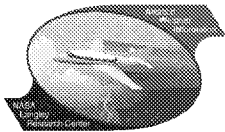


NASA Ground Tests

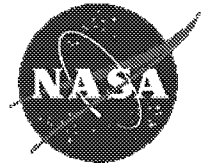


NASA Ground Tests

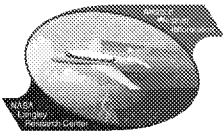




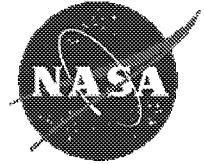
NASA Flight Test



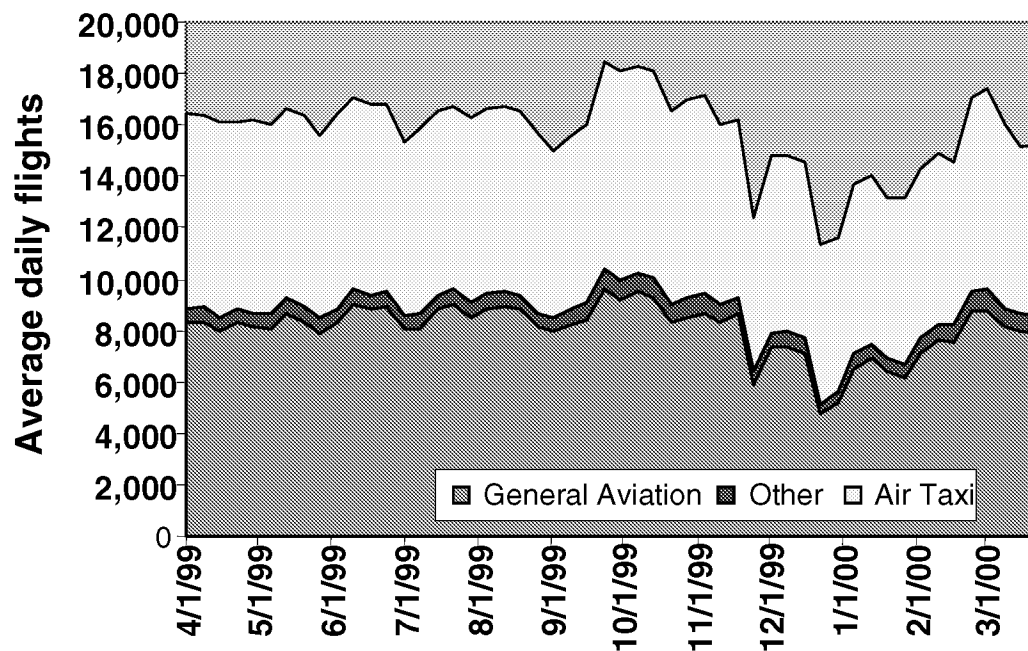
- Three flight test series scheduled, August – November 2001
- AWIN, WINCOMM coordination for data link testing
- Goal: To provide support to WINCOMM for TAMDAR system architecture tests (Cessna 206H)
- TAMDAR in support role, not central research effort



ETMS Analysis of IFR Flights

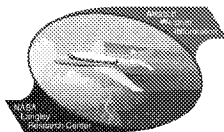


Average weekly operations over 12 months

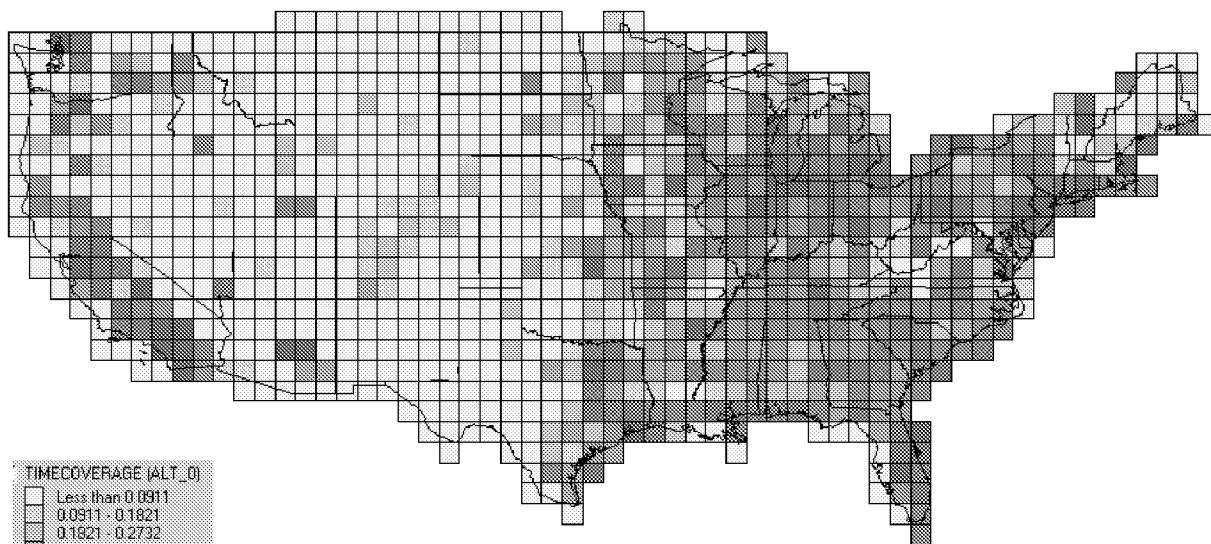
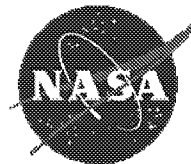


Many thanks to Nancy Kalinowski, ATA-2

Source: FAA ATA-200 AT Airspace Lab Brent Brunk



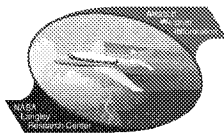
ETMS Analysis of IFR Flights



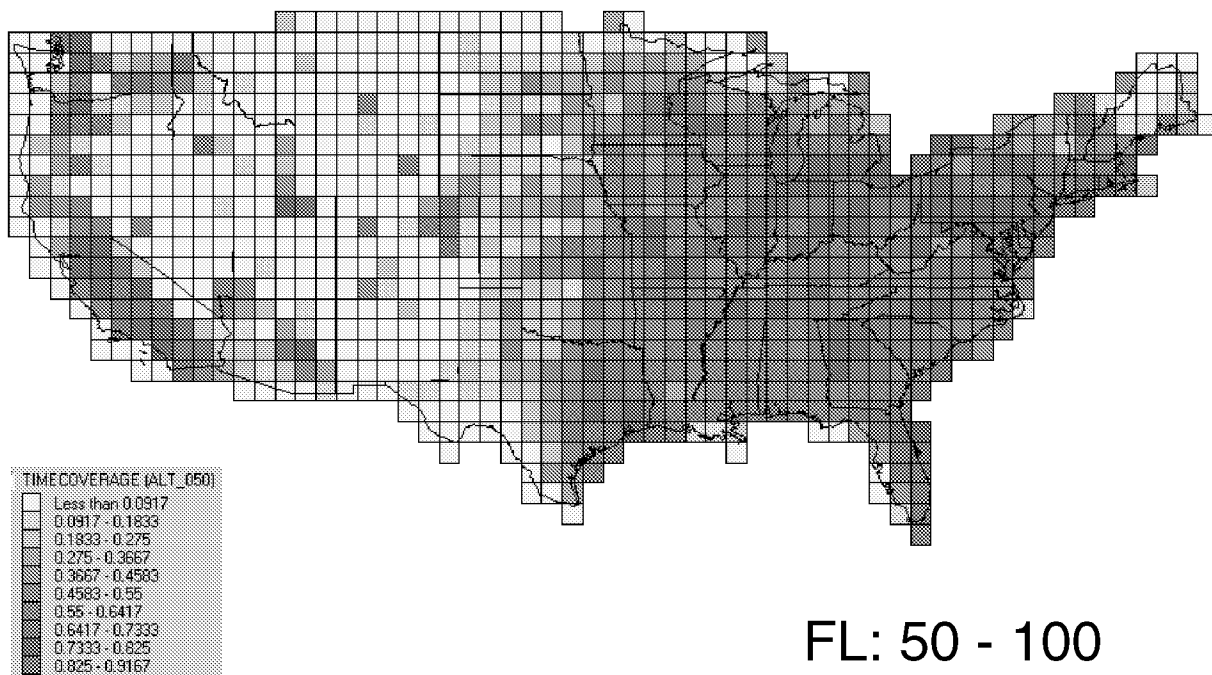
TIMECOVERAGE (ALT_0)

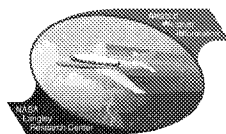
Less than 0.0911
0.0911 - 0.1821
0.1821 - 0.2732
0.2732 - 0.3643
0.3643 - 0.4554
0.4554 - 0.5464
0.5464 - 0.6375
0.6375 - 0.7286
0.7286 - 0.8196
0.8196 - 0.9107

FL: 0 - 50

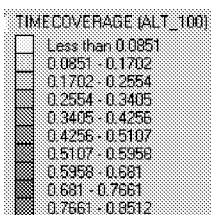
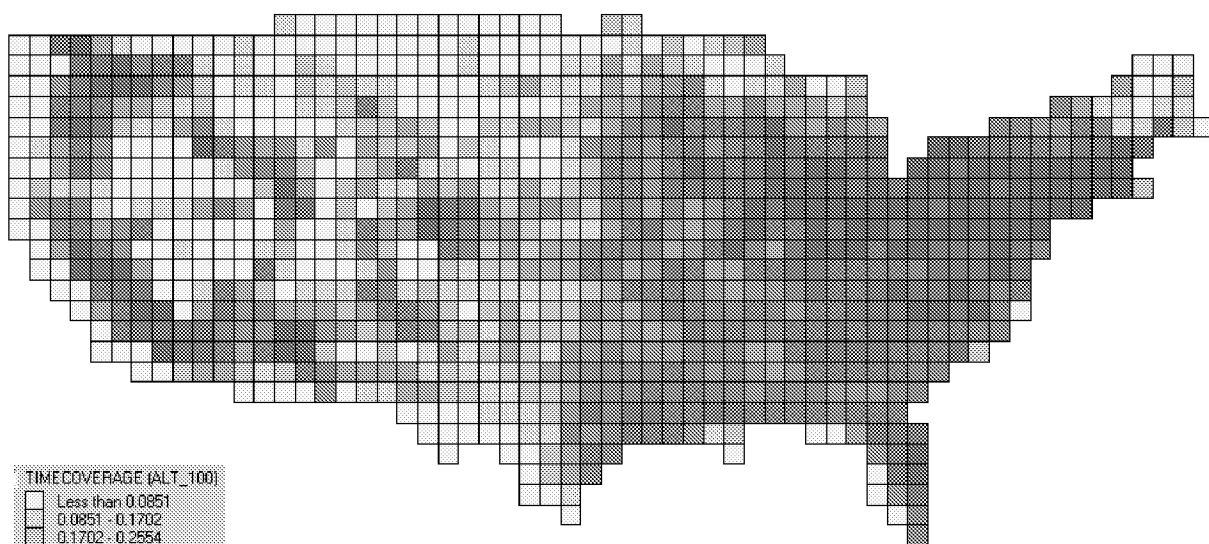
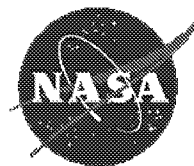


ETMS Analysis of IFR Flights

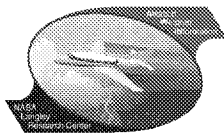




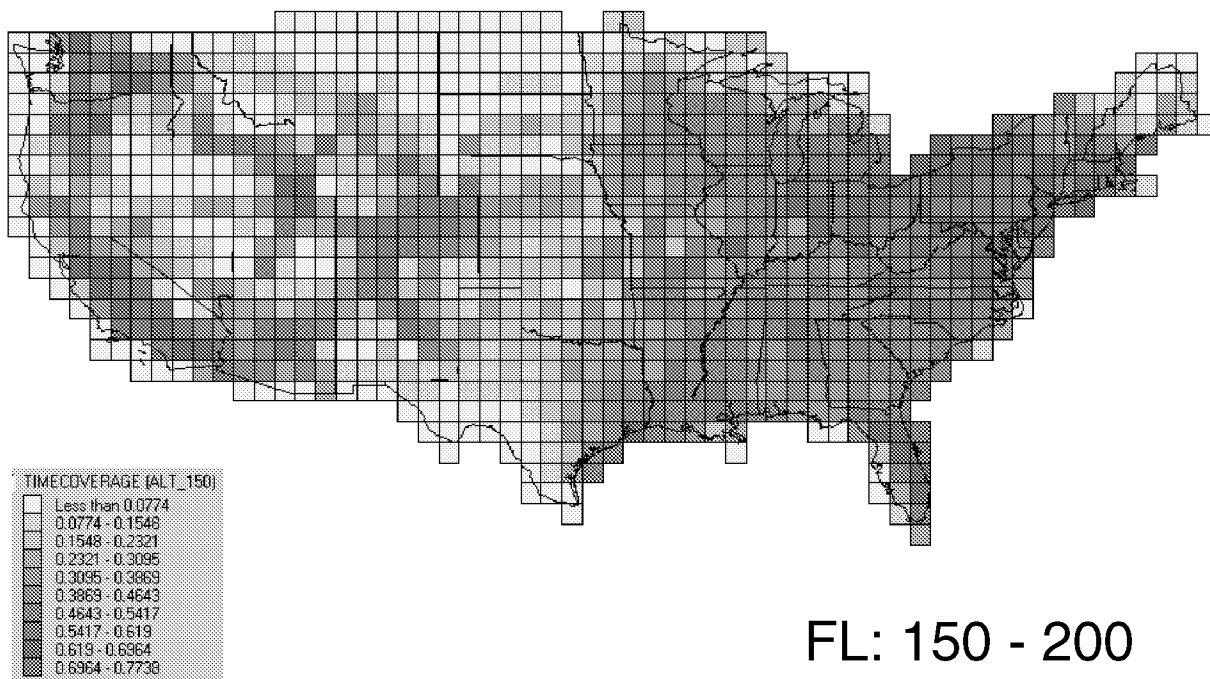
ETMS Analysis of IFR Flights

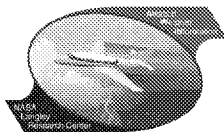


FL: 100 - 150

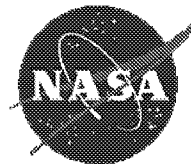


ETMS Analysis of IFR Flights

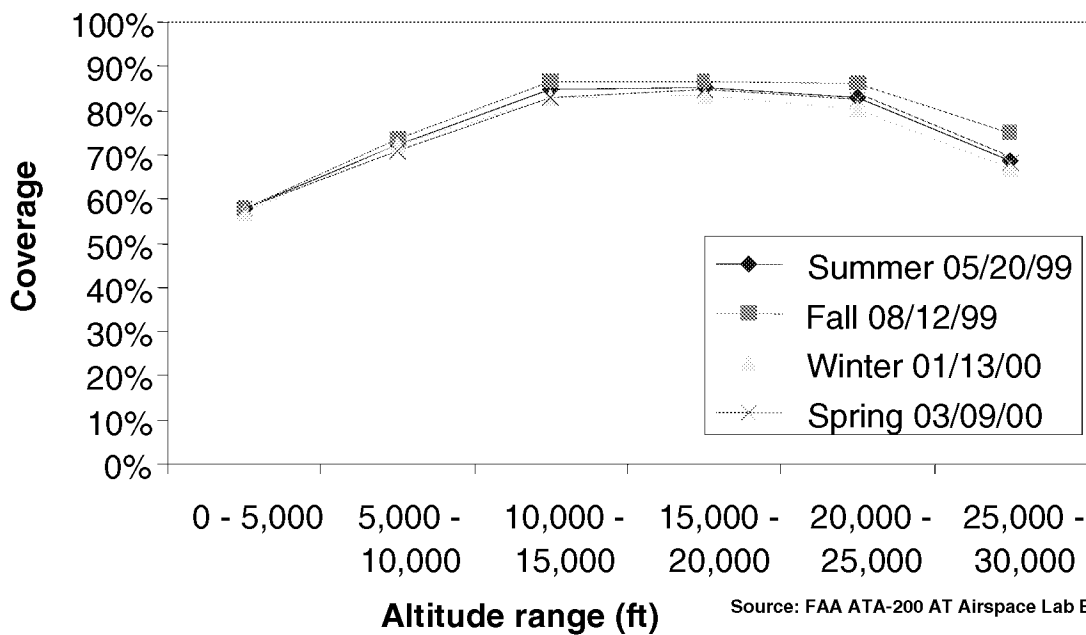


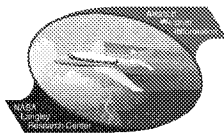


ETMS Analysis of IFR Flights



Estimated % CONUS Coverage of TAMDAR flights



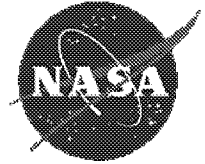
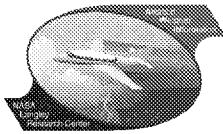


Capstone and TAMDAR

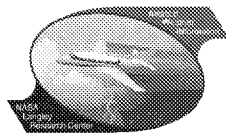


- FAA Capstone agreed to AWIN proposal to include TAMDAR into Bethel Area operational evaluation
- NASA to deliver 10 certifiable sensors
- FAA Capstone to support equipage, certifications, installations, and modifications to communications infrastructure
- ODS to support installations and calibrations

Tri-Agency TAMDAR Team



- Representatives from NASA Langley, NASA Glenn, FAA ARW-100, FAA AUA-400, NOAA FSL, NOAA NWS meet to coordinate activities related to TAMDAR
- First action: No longer use term “E-PIREP”
- Currently drafting “Concept of Operations”

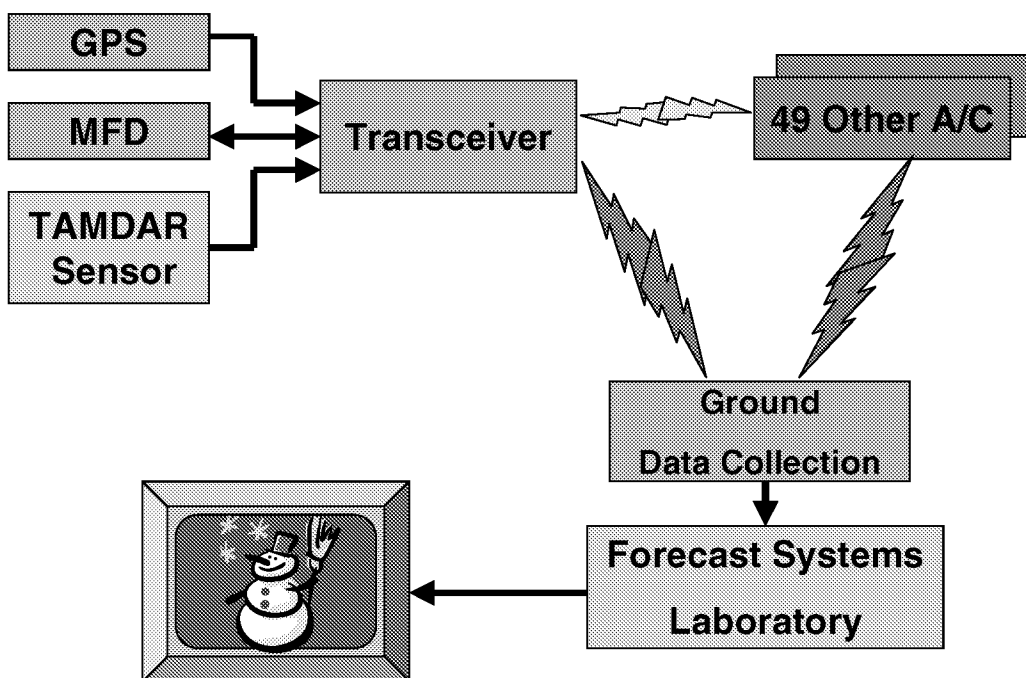


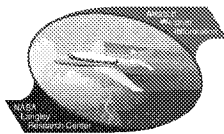
NOAA FSL Activities



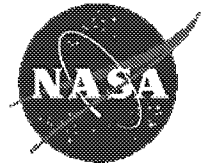
- Goal of Fleet Operational Evaluation is to get the data to NOAA Forecast Systems Lab
- Challenges for FSL:
 - Provide consultation on sensor development
 - Identify and establish sources of corroborative weather information
 - Perform data validation, collection, storage and archival
 - Investigate meteorological phenomena revealed by this new high resolution data
 - Develop new weather products

Fleet Operational Evaluation Concept



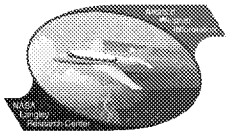


Candidate Communications Links

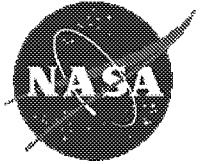


Disseminate data to NOAA FSL via one of the following:

- ARNAV
- Honeywell
- UPS AT
- EchoFlight
- ARINC
- Cellular Modem
- FlyTimer
- Orbcomm
- SITA

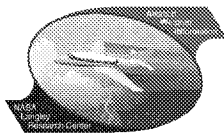


Fleet Operator Selection Criteria

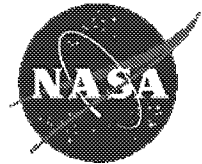


- Two or more fleet operators
- At least 50 aircraft of same type
- 24 x 7 operations
- Extensive routes in geographically diverse regions
- Can be FIS & TAMDAR equipped
- Can participate in 6 month duration research project
- Candidates: UND, ERAU, OU, United Express, UPS, Federal Express

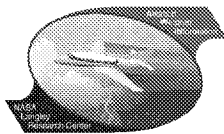




Calibration Issues



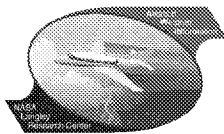
- Sensors are factory calibrated
- Capability to perform field calibration with external connection to instrumentation
- Possibly perform self-checking via ASOS or other sources via data link
- Ground truth checking at FSL
- Need to establish calibration schedule and standards
- Some pilot training may be involved



Certification for Fleet O. E.



- Fleet Operational Evaluation would require:
 - FAA Certification of sensor
 - Selection of fleet operator and aircraft type
 - Certification Plan
 - RTCA DO-160E testing

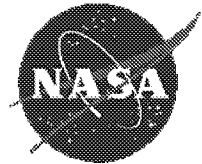
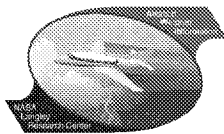


National Demonstration



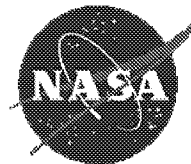
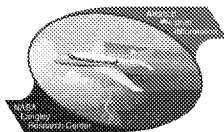
- AvSP goal for a 2002 National Demonstration
- Some Potential Activities Include:
 - Cessna 206H cross-country flight with data link
 - B200 King Air (NASA 8) flights with data link
 - International Water Vapor Experiment (IHOP) using University of Wyoming King Air with data link
 - Planned Fleet operational evaluation most likely to occur in 2003

Alternate Method

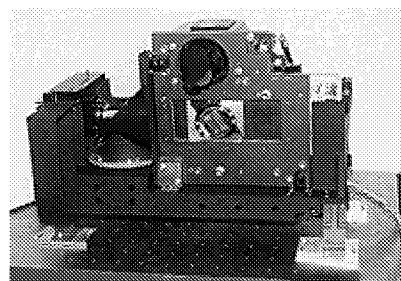
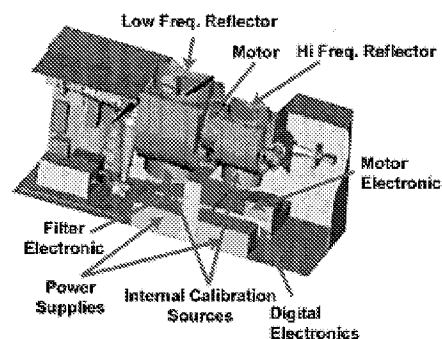


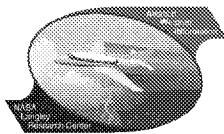
- NPOESS – National Polar Orbiting Operational Environmental Satellite System – DoD, NASA, NOAA team with partners EUMETSAT and NASDA
- 5 NPOESS satellites, deployed from 2008 to 2011, operational through 2018, each equipped with a subset of ten different sensors.
- ATMS – Advanced Technology Microwave Sounder
- VIIRS – Visible Infrared Imaging Radiometer Suite
- CrIS – Cross-track Infrared Sounder

Alternate Method



- **ATMS – Advanced Technology Microwave Sounder**
 - Ten altitude bands, from 4 to 37 Km
 - Measures water vapor and temperature
 - 32 Km spot size
- **CrIS – Cross-track Infrared Sounder**
 - Measures water vapor, temperature and pressure
- **VIIRS – Visible Infrared Imaging Radiometer Suite**
 - Measures temperature and pressure





Summary



- NASA FAA NOAA Industry Collaborative Effort
- TAMDAR Sensor Development
- Ground/Flight Testing
- FAA Capstone
- NOAA FSL
- WINCOMM Datalink Evaluation
- Fleet Operational Evaluation
- AWIN National Demonstration