Weather Technology in the Cockpit (WTIC) Program

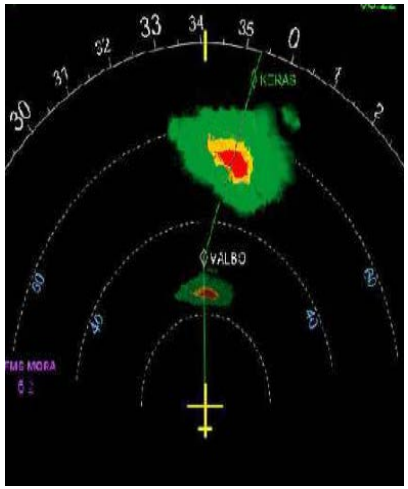
Turbulence Workshop Presentation

Date: September 3, 2014

The Notional WTIC Cockpit?

Weather Technology in the Cockpit (WTIC)

Program Overview



- NextGen research program
- Portfolio of research projects
- Develops, verifies and validates requirements for standards
- Identifies safety risks and operational inefficiencies attributable to gaps of meteorological (MET) information in the cockpit and resolves those gaps

Part 121/135 Research Tasks

- Recommend a Minimum Weather Service (MinWxSvc) to achieve WTIC Program objectives
  - Minimum cockpit MET information
  - Minimum performance parameters (i.e., accuracy, latency, availability) of cockpit MET information
  - Minimum rendering standards to enable correct and consistent interpretation
- Identify current and NextGen operational inefficiencies attributable to gaps of MET information in the cockpit

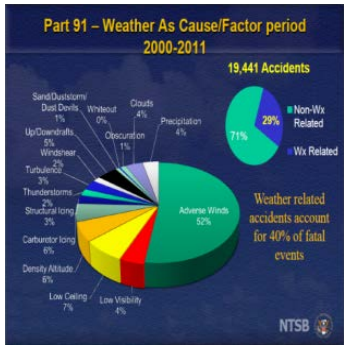
Part 91 Research Tasks

- Recommend MWS to enhance safety
- Identify causal factors for GA Wx-related accident rate
- Identify shortfalls in pilot understanding and proper use of MET information and training to resolve those shortfalls
- Determine GA willingness to spend on equipage and services for MWS

Portfolio Overview

- Approximately 9 ongoing GA projects and 9 ongoing Part 121/135 projects
- Sample Part 121/135 projects
  - Eddy Dissipation Rate (EDR) uplink
  - Wind Requirements Study
  - Adverse Weather Alerting
- Sample GA Projects
  - Mobile MET
  - Accident causality assessments
  - MET information rendering assessments
  - Adverse Weather “alerting function(s)”

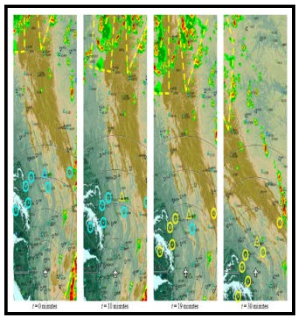
WTIC Part 91 Projects



NTSB Briefing Slide – Summer 2013 FPAW

Overview

- Causality Assessments of Wx Related Accidents
- Inadvertent flight into Instrument Meteorological Conditions (IMC) gap analysis
- Shortfall analysis of current cockpit MET products
- Adverse weather alerting
- Mobile MET application MWS
- Probabilistic weather



Recent Accomplishments

- Developed a prototype tool and draft MWS Mobile MET application recommendations
- Demonstrated probabilistic information positive impact on GA separation from convection
- Investigated 319 VFR to IMC accidents, degraded visual over 75%
- Created weather indexing tool to support analyses (Wx accidents much higher rate of decision errors than other GA accidents)
- Developed use case scenarios for assessing weather alerts
- Identified gaps in weather product rendering and conspicuity of information

Plans

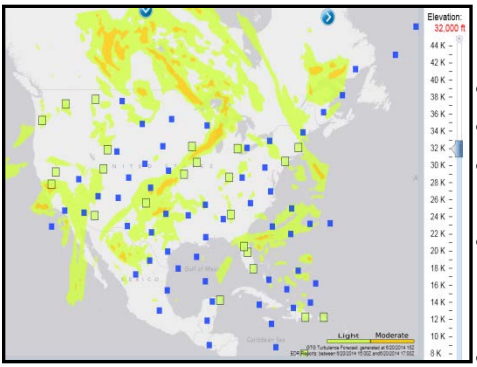
- Assess benefits of candidate alerts and perform trade studies (FY15)
- Continue to investigate options for incorporating probabilistic MET information in cockpits (FY15)
- Develop weather factors risk matrix (FY14)
- Perform lab evaluation of Mobile MET application prototype tool (FY15)
- Develop rendering recommendations (FY16)

Collaboration

- Work with NWS to ensure that cockpit weather needs are and understood, and eventually met by either existing or new products
- Use the data/gaps we uncover and share strength and weaknesses of available weather information with NWS
- Review accidents, incidents, NTSB recommendations and more to respond collaboratively and consistently

WTIC Part 121/135 Projects

Overview



- Eddy Dissipation Rate (EDR) Uplink and Technical Transfer
- Wind Requirements Study
- Adverse Weather Alerts
- Ocean and Remote Regions Shortfall Analyses
- Predictive Model for Aircraft Behavior in the Vicinity of Convective Weather
- Technical Support to RTCA SC-206

Recent Accomplishments

- Running operational demonstration on cockpit display of turbulence information
  - Benefits to follow
- Conducted studies to evaluate bandwidth constraints on downlink/uplink of MET information
- Study on the industry perspective to obtain idealistic view of weather in the cockpit from all aviation sectors
- Completed a WTIC Concept of Operations
- Evaluation of multiple flight displays of Corridor Integrated Weather System (CIWS) and Convective Weather Avoidance Model (CWAM)

Plans

- Identify alert recommendation for MWS (FY16)
- Complete EDR technical transfer package (FY15)
- Provide trade studies on wind accuracy to support advanced NextGen concepts (FY15)
- Make recommendations for incorporating probabilistic weather in the Part 121/135 and Part 91 MWS (FY18)
- Develop rendering recommendations (FY20)

Collaboration

- Work with NWS to ensure that cockpit weather needs are and understood, and eventually met by either existing or new products
- Use the data/gaps we uncover and share strength and weaknesses of available weather information with NWS
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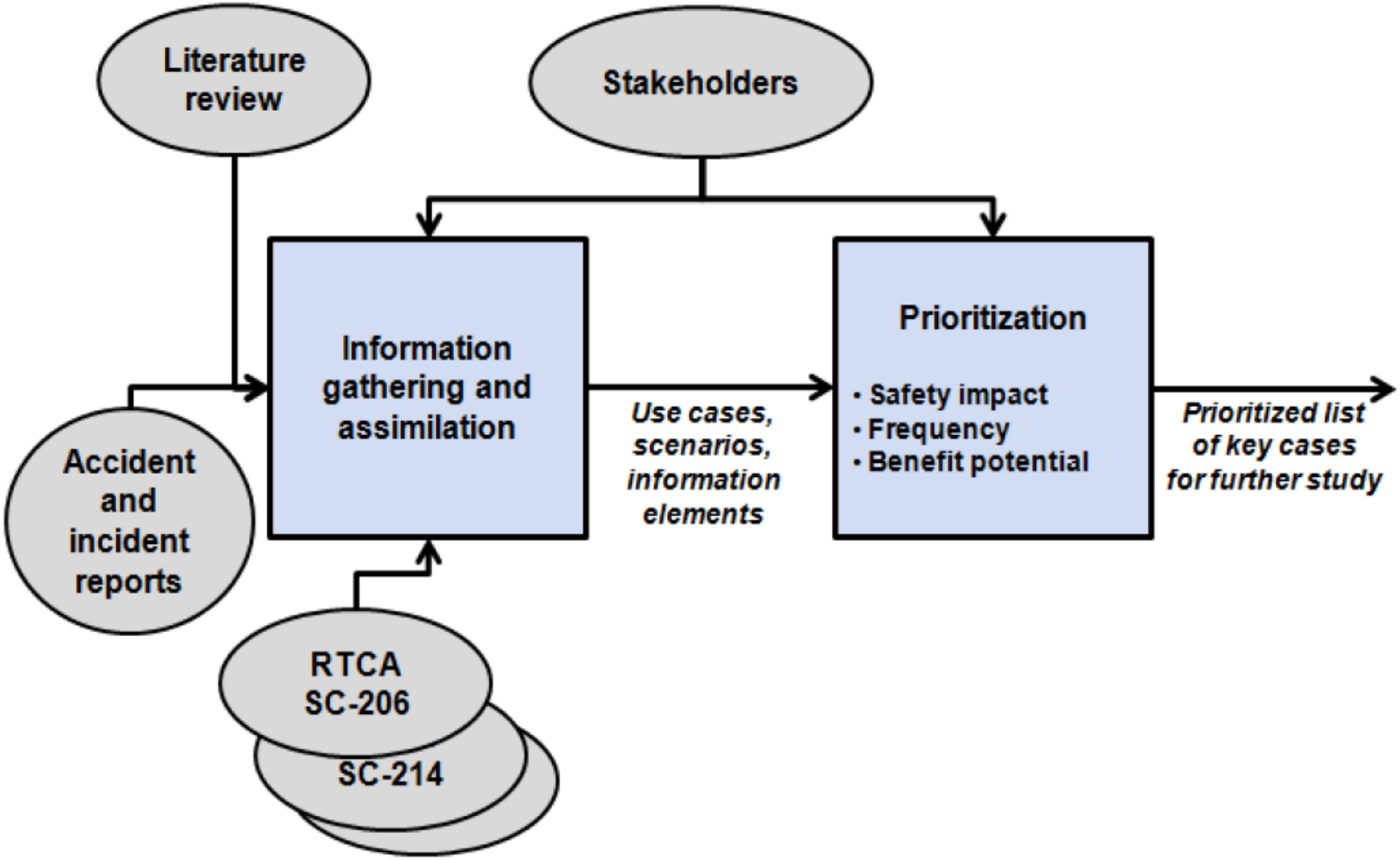
WTIC Part 121/135 Weather Alert Projects

- **Two categories of adverse weather alerting functions being research by WTIC Program for inclusion in MinWxSvc**
  - Tactical Alerting: function alerts pilot that an adverse weather condition is going to be encountered, not intended to assist in avoidance decisions
  - Strategic Alerting: function alerts pilot of meteorological (MET) information to be used to assist in efficient and safe adverse weather avoidance decision making

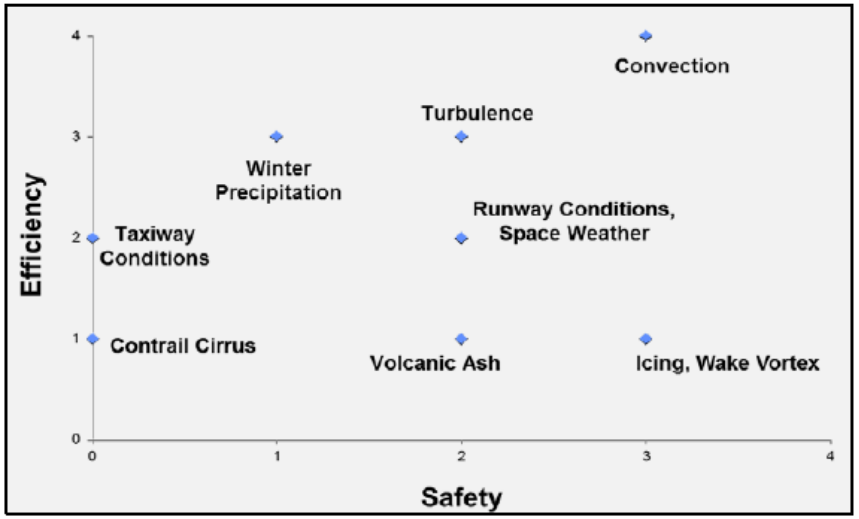
Use Case Prioritization



MET Condition Prioritization

Part 121

	Frequency	Safety	Efficiency	Total
Convection	3	3	4	10
Turbulence	4	2	3	9
Winter Precipitation	3	1	3	7
Runway Conditions	2	2	2	6
Wake Vortex	2	3	1	6
Icing	2	3	1	6
Volcanic Ash	1	2	1	4
Taxiway Conditions	2	0	2	4
Space Weather	0	2	2	4
Contrail Cirrus	2	0	1	3



Part 91(k)/135

	Frequency	Safety	Efficiency	Total
Icing	2	4	2	8
Convection	1	3	4	8
Runway Conditions	3	3	1	7
Wake Vortex	2	3	1	6
Turbulence	2	1	2	5
Winter Precipitation	3	1	1	5
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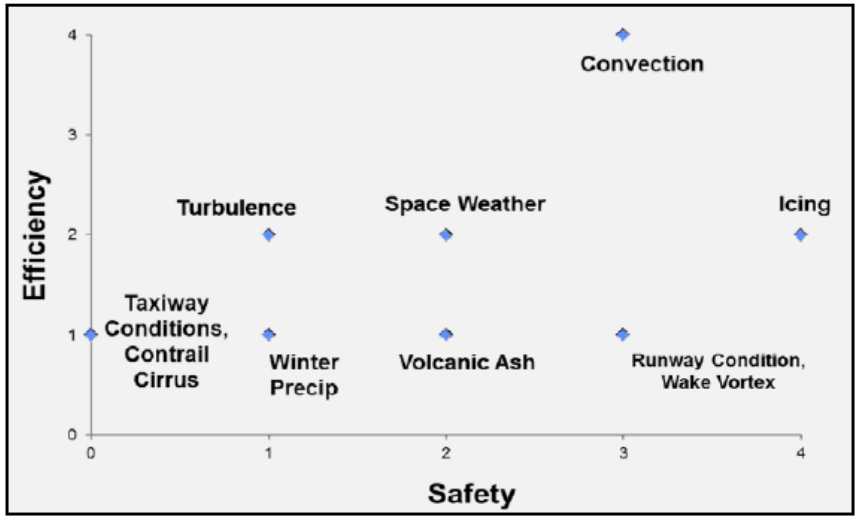


MET Alerting Conditions

MET Alerting Condition	Description
Convection	Any convective induced phenomena such as turbulence, lightning, microburst, icing, and hail.
Turbulence	Any non-convective induced turbulence such as clear air turbulence, mountain wave turbulence, and wind shear.
Winter Precipitation	Winter precipitation type such as snow, freezing rain, and ice pellets, as well as the precipitation rate. A primary factor in deicing holdover time calculation.
Runway Conditions	Any runway surface condition such as snow, ice, braking friction, surface wind. This category also includes ceiling and runway visibility.
Wake Vortex	Any wind condition that would result in a wake vortex persisting or encroaching on an approach or departure path.
Icing	Any airframe or engine icing condition.
Volcanic Ash	Any plume of volcanic ash that would interfere with safe operations.
Space Weather	Any radiation condition that would result in a loss of navigational or communications capabilities.
Taxiway Conditions	Any contamination on the taxiway such as snow or ice.
Contrail Cirrus	Any relative humidity condition that would result in persistent contrail cirrus, which is a contributor to environmental impact.

Alerting Benefit Categories

Safety

- Turbulence – Convective and Non-convective (injuries to flight attendants and passengers)
- Runway conditions
- Wake turbulence
- Icing
- Volcanic ash
- Space weather

Efficiency

- Turbulence (frequency congestion)
- Convection
- Winter precipitation
- Runway conditions
- Taxiway conditions
- Space weather
- Contrail cirrus

Example Efficiency Shortfalls to Resolve

- **WTIC Concept of Operations**
  - Lack of strategic weather information leads to reactive decision making and unpredictability in the NAS
  - Lack of information in the cockpit to support trajectory based operations
  - Excessive workload / voice communications due to pilot reports

- **WTIC Industry Perspectives Report**
  - Lack of common information between dispatch and the cockpit
  - Onboard weather radar can be inaccurate
  - Lack of graphical weather in the cockpit

Candidate Strategic Turbulence Alert

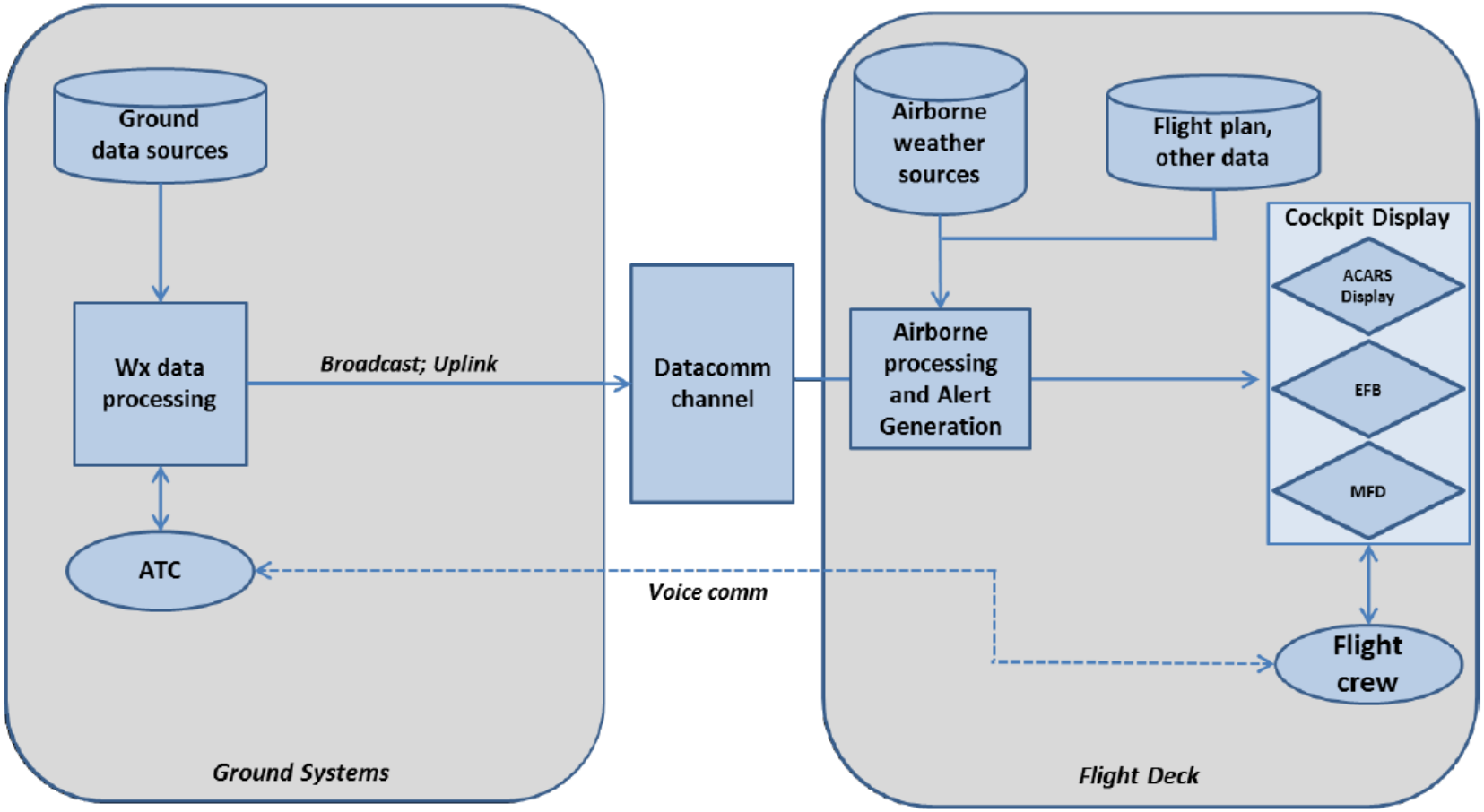
Domain: Terminal or En Route

Mode: Broadcast

MET Info: SIGMET

Service: WNDS

Data Flow: Uplink



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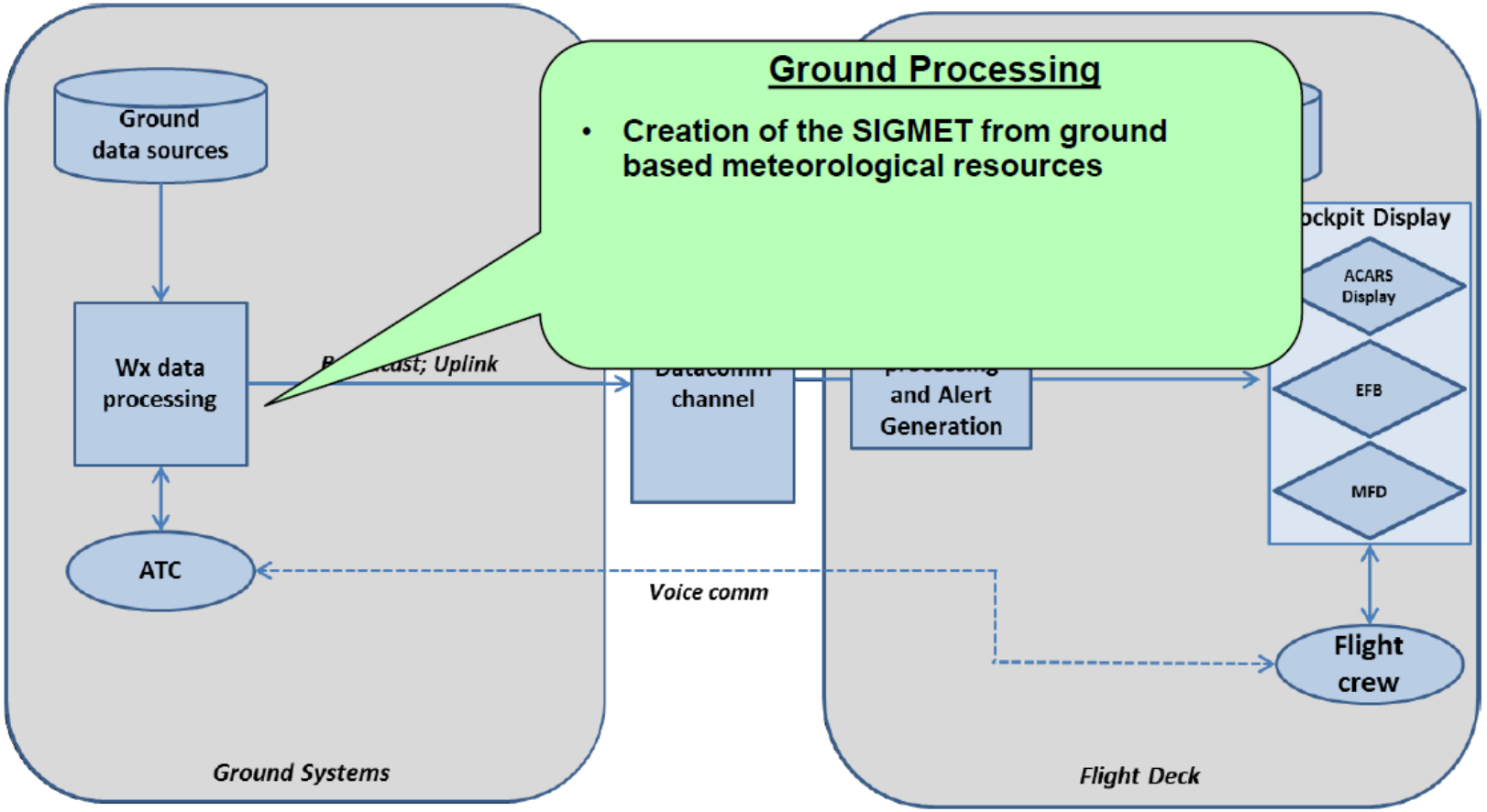

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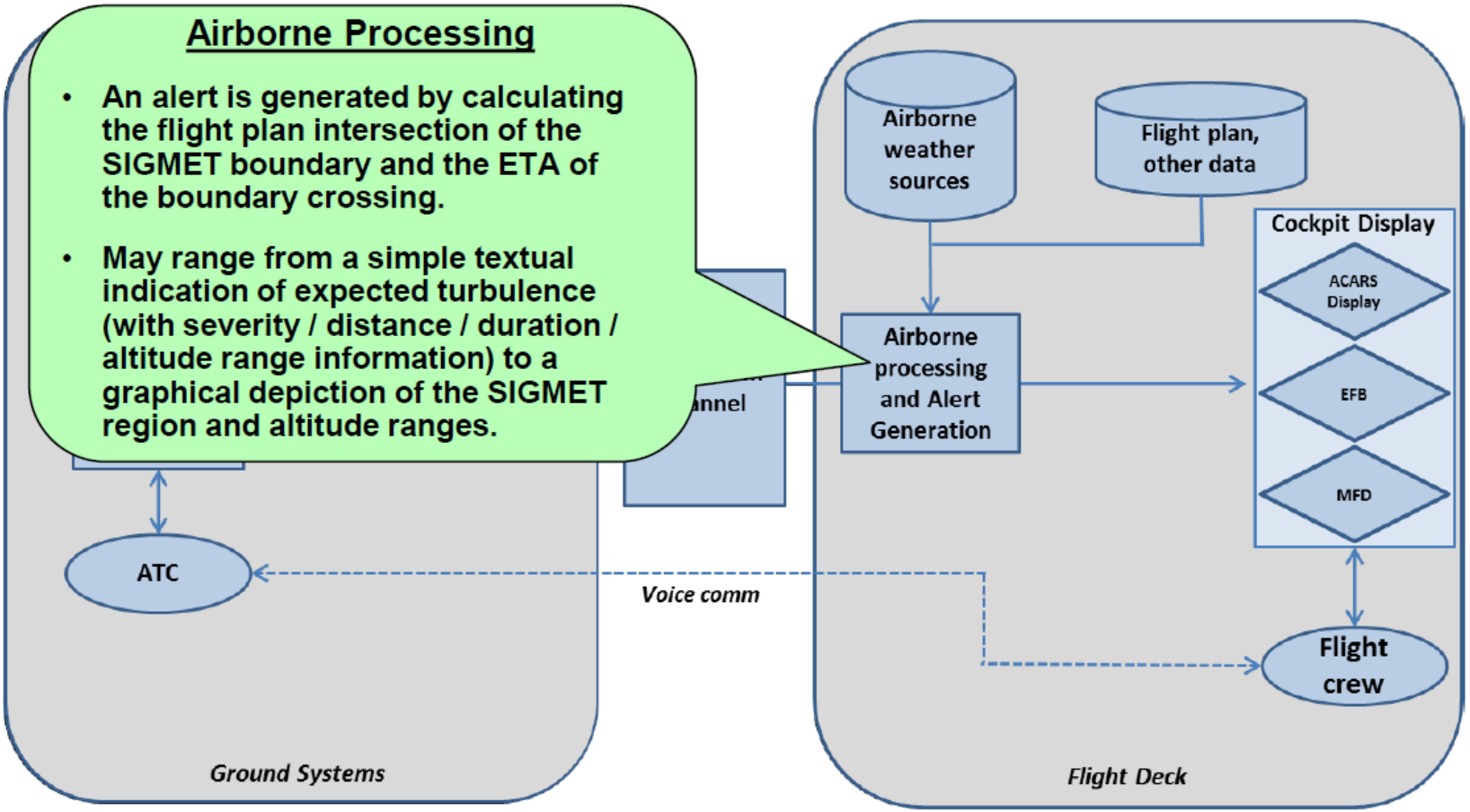
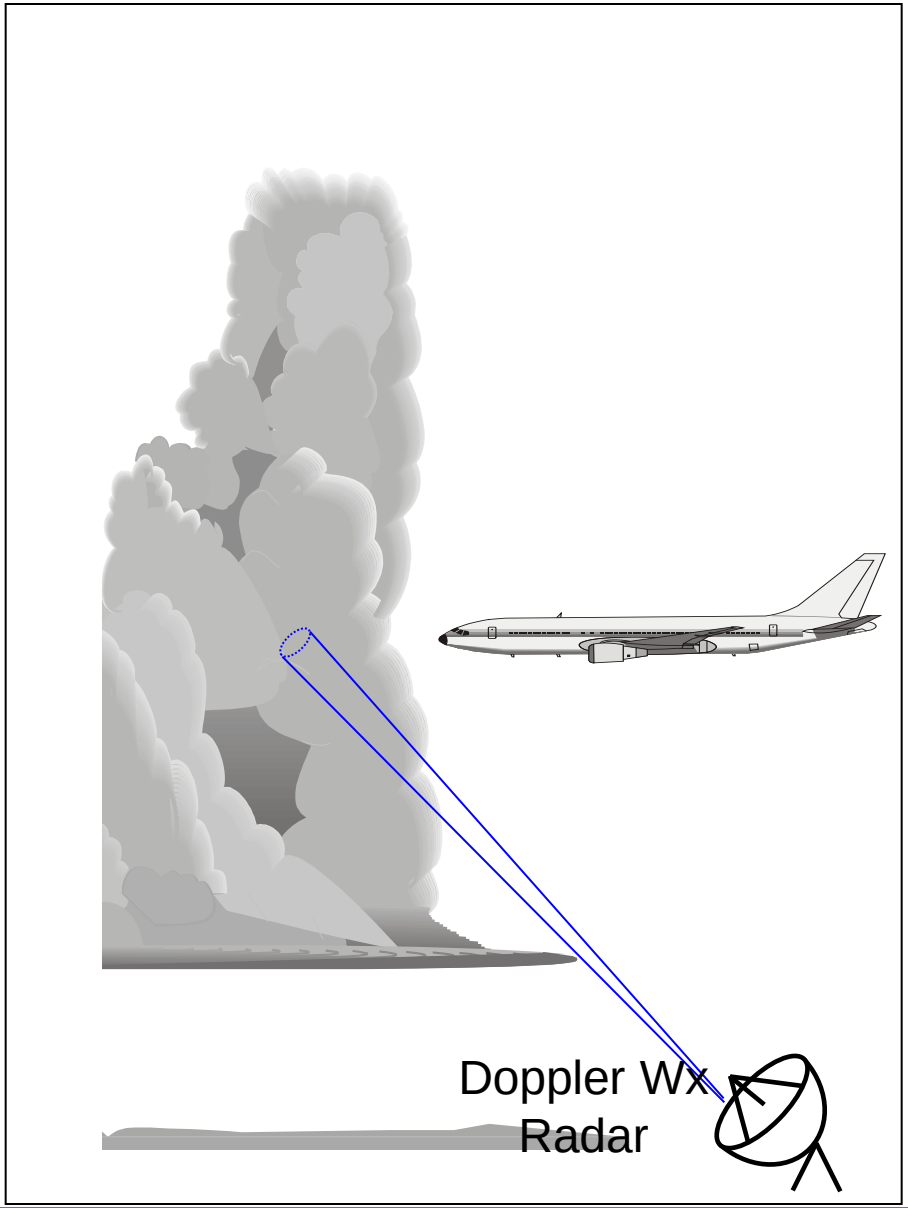


Tactical Turbulence Alerting Function

- **Provide near real time notification of impending turbulence encounter**
- **Alerting function to assist with crew management versus turbulence avoidance**
- **Primarily addressing safety risk**
- **Plan to perform demonstration using NCAR's NEXRAD Turbulence Detection Algorithm (NTDA)**

What is the NTDA?

- **The NEXRAD Turbulence Detection Algorithm uses Doppler weather radar data to measure turbulence in clouds, complementing GTG and radar reflectivity.**



What does NTDA measure?

- **Atmospheric turbulence: eddy dissipation rate (EDR),**
  - EDR can be converted to the impact on an aircraft based on the aircraft type and flight parameters
- **NTDA only measures turbulence where sufficient wind-tracing reflectors exist, i.e., in clouds and storms**
  - Focus on in-cloud convectively-induced turbulence

How can NTDA data be used?

- **Tactical decision support for en-route aircraft**
  - Improve situational awareness, airspace utilization, and safety.
  - May help obviate the need for “pathfinder” aircraft after airspace closures
- **Measurements may be assimilated into turbulence nowcasts**
- **May be used as verification “truth” data for turbulence forecasts**

Simulation Evaluation

- **Propose using a day in the life type scenario such as Case Study 1**
- **Data Collection**
  - Pilot response during flight simulation
  - Pilot post flight simulation questionnaire
  - Data capture from data received from NCAR
  - Post event download to NCAR

Tactical Turbulence Alerting Notional Architecture