Weather Technology in the Cockpit (WTIC) Alaska-Related Research

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WTIC Program Overview

- Portfolio of research projects to develop, verify, and validate requirements recommendations to incorporate into Minimum Weather Service (MinWxSvc) standards and guidance documents
- We define MinWxSvc as:
  - Minimum cockpit meteorological (MET) information
  - Minimum performance standards/characteristics of the MET information
  - Minimum information rendering standards
  - Enhanced MET training

WTIC Program Objectives

- Enhance General Aviation (GA) safety by identifying and resolving risks before they become accidents
- Incorporate MinWxSvc recommendations into standards and other guidance documents
  - Enables NextGen operations and benefits, and pilot roles
- Resolve operational (current and NextGen) inefficiencies associated with adverse weather
- Enhance pilot MET-training to enable effective and consistent adverse weather decision-making

WTIC is not building cockpit applications so outreach to industry is necessary for implementing MinWxSvc(s).

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Examples of Gaps Being Addressed

Knowledge Gaps

1. Lack of training (mainly due to little opportunity) for student pilots to fly in and experience different weather patterns and their associated visual and other cues.
2. GA pilots often do not understand the limitations of the technology in the cockpit.

Skills Gaps

1. There is a perceived gap in skills related to VFR--into--IMC decision-- making.
2. Lack of Situational Awareness relating to VFR--into--IMC.
3. Retention of weather knowledge was identified as a gap.

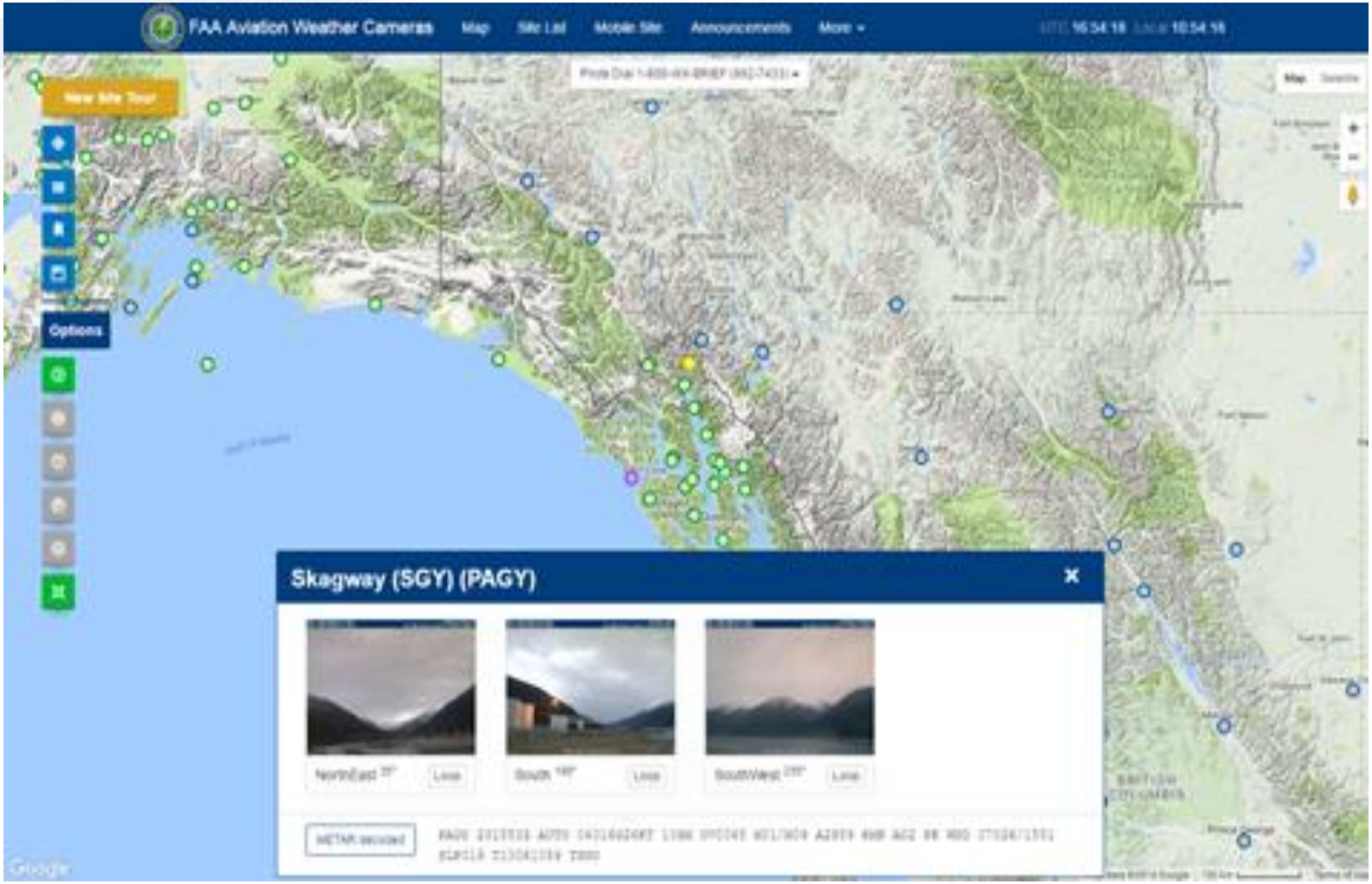
Ability Gap

1. Lack of ability of pilots to correlate, interpret and apply weather information related to VFR-into-IMC Weather Factors, specifically convection, icing, lowered ceilings, quickly emerging weather events, precipitation, or pilot-reported turbulence.

WTIC - Alaska Related Research

- Crowd Sourced Visibility (and potentially ceiling) Information
- Objective Criteria for Visual Flight Rules (VFR) Not Recommended (VNR) Issuance
- Using Camera Analytics to Calculate Wind Information at Uncontrolled Airports

Crowd Sourcing Project



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Definition of Meteorological Visibility

- ICAO Annex 3 Meteorological Service for International Air Navigation contains the following definitions and note:

  a) the greatest distance at which a black object of suitable dimensions, situated near the ground, can be seen and recognized when observed against a bright background;

  b) the greatest distance at which lights of 1,000 candelas can be seen and identified against an unlit background.

  Note: The two distances have different values in air of a given extinction coefficient, and the latter b) varies with the background illumination. The former a) is represented by the meteorological optical range (MOR).

- So visibility is a measure of the distance at which an object or light can be clearly discerned. Meteorological visibility refers to transparency of air.

WTIC – Crowd Sourced Visibility

- Goals
  - Determine whether Crowd Sourcing weather information using cameras produces useful visibility information
  - Prototype Crowd Source architecture for visibility information using Alaska Webcams
  - Evaluate outputs of crowd sourcing for pilot utility
    - Investigate potential for use as model observation inputs
    - Compare utility of crowd source output to Webcam images

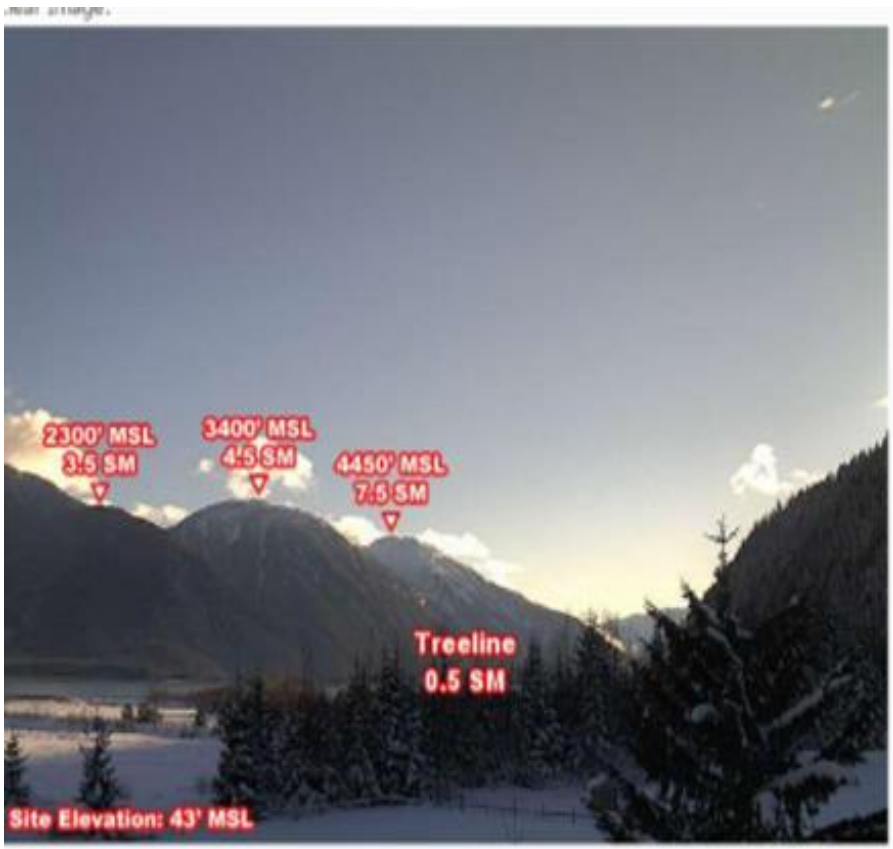
WTIC – Crowd Sourced Visibility

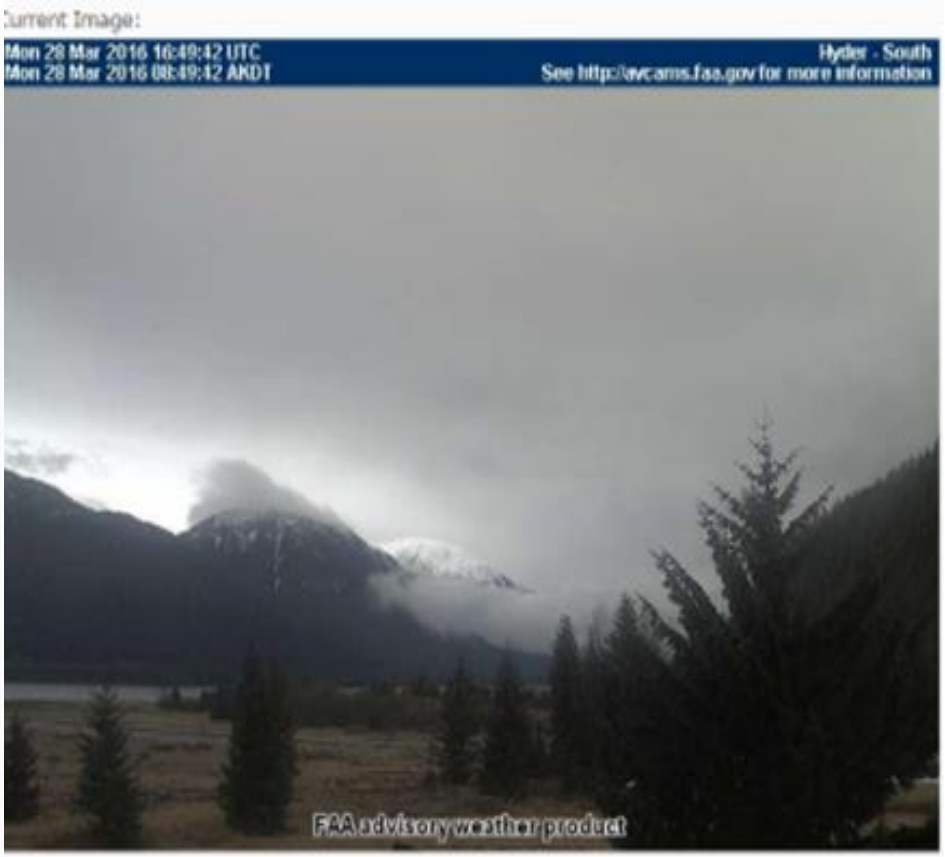
- Prototype Architecture
  - Used Amazon Mechanical Turk
    - Commercial crowd sourcing infrastructure, pay as you go
    - Provides 24/7 access to worldwide “crowd” of “workers”
  - Expectation Maximum (EM) algorithm to converge to solution
    - Rate workers based on past performance (better workers lead to quicker convergence, weed out poor workers)
  - Minimal training for workers
  - Use Alaska webcams and third party camera
  - Use Google Earth to add reference markers

Human Intelligence Task- Example

Instructions

For the images below, use the clear air image as a reference and estimate the ground visibility (in Statute Miles) in the current image. If the image is entirely obscured, set a value of 0.0. If the visibility exceeds the scale, just set the maximum value of the scale.





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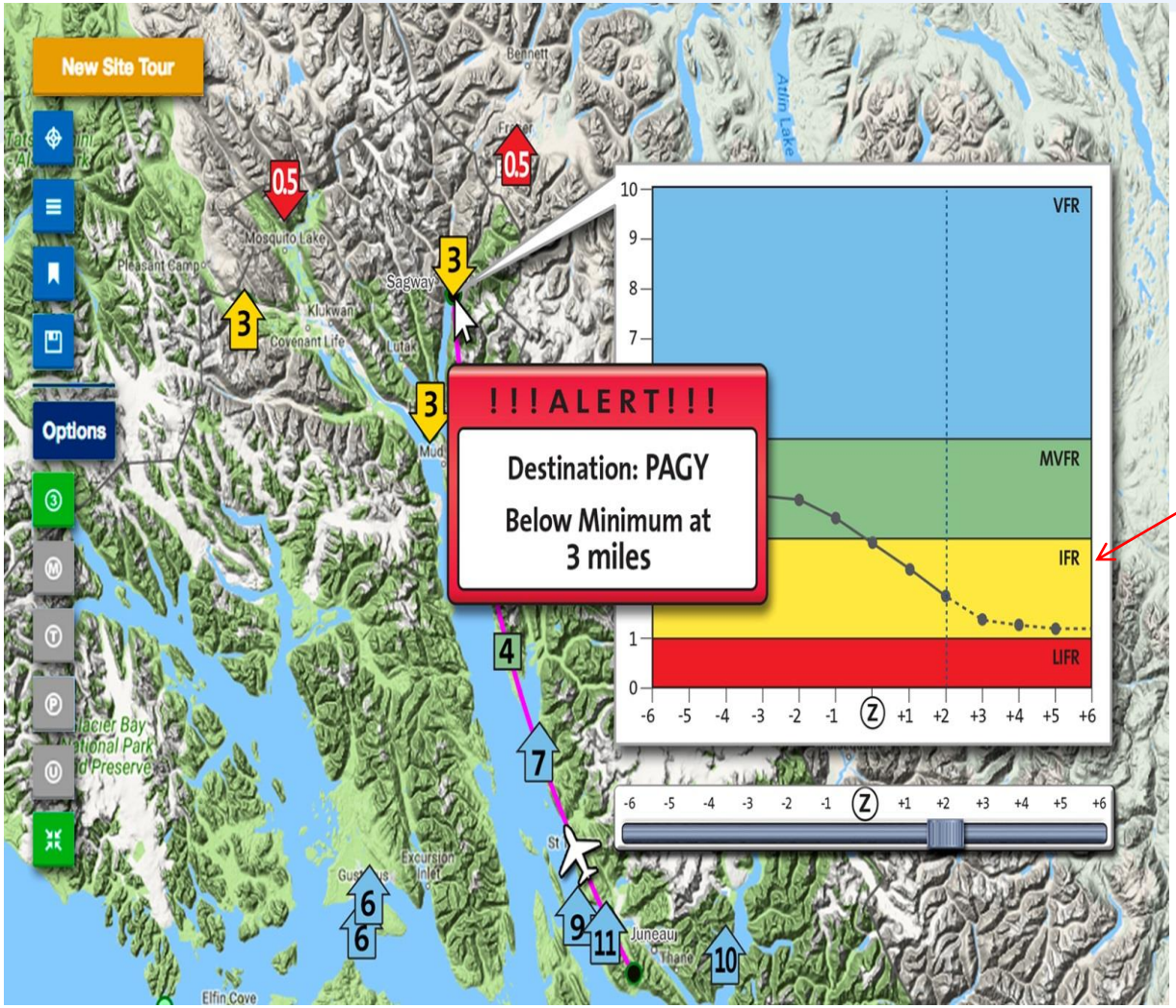
Sample Output From Crowd Sourcing



Slider set to display
2 hour forecast

WTIC – Crowd Sourced Visibility

- Summary of Findings
  - 81.4% of the visibility results were within 20% of the ASOS visibility
  - 16.5% were between 20% and 50%
  - 2% were more than 50% from ASOS visibility
  - ASOS results may not always provide maximum utility to pilots in “challenging” visibility conditions
    - Pilot assessments of visibility conditions varied greatly
  - Some cameras are not good choices for crowd sourcing

WTIC – Crowd Sourced Visibility

- Summary of Findings
  - Pilots found Crowd-Sourced outputs easier to evaluate than images and the FAA Camera looping for trends
  - Pilots trusted Crowd-Sourced results compared to their own assessments
  - Decision times on visibility significantly reduced
  - Mechanical Turk provided large pool of workers, but participants varied so difficult to keep rated workers
  - Hybrid system using machine learning and edge detection may provide best value and solutions

WTIC – Crowd Sourced Visibility

- Additional Opportunities
  - Crowd-Sourced Visibility + Model Output could yield a short term visibility prediction.
  - Machine learning technique and pictures from demo may have potential for training pilots to better assess visibility
    - Large variation seen in pilot assessment of visibility using webcam images
  - Assess Ceiling using Crowd Sourcing
  - Crowd source forward looking radar
- Transition Questions
  - What QA is necessary to transition to use?
  - How to get a consistent work force?
  - What are NWS needs for ceiling?
  - What is best method for challenging visibility?
    - Single value, flag, range?

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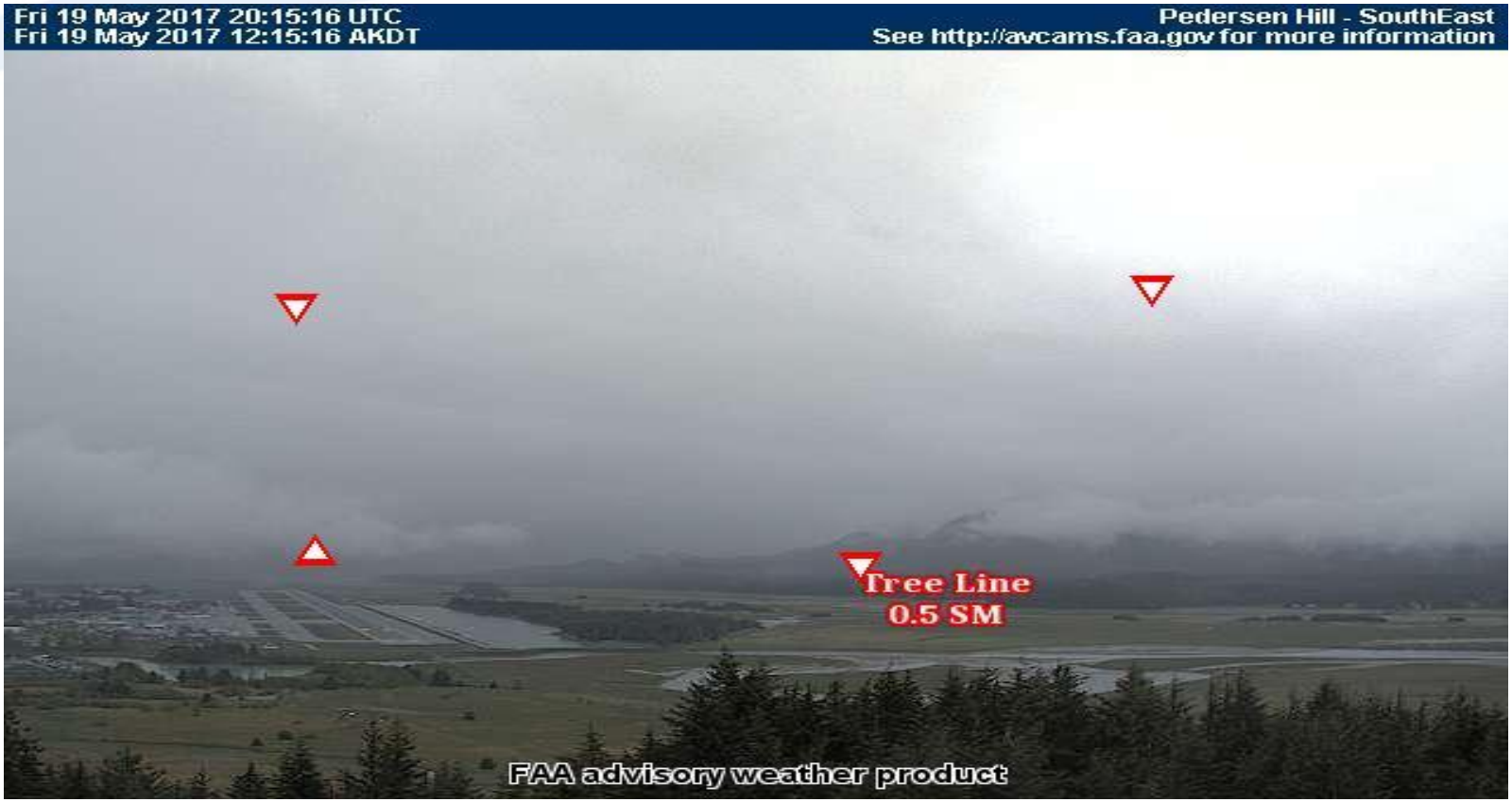
VFR not Recommended (VNR) Project



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WTIC – VNR Project

- Goals
  - Investigate GA pilot (based on inputs from AOPA) concern that VFR not recommended (VNR) is over forecast which reduces its utility
    - Compare pilot, flight station specialist, and flight instructor thresholds for VNR issuance
  - Identify objective thresholds for VNR issuance and MET products used to assess the thresholds
    - Reduce subjectivity in issuance
  - Evaluate impact on pilot decision making of providing flight categories versus visibility numbers
  - Make recommendations for objective issuance of VNR and associated VNR statement

WTIC – VNR Project Summary

- Demo Plan
  - Provide various weather scenarios and standard MET products to flight service specialists, GA pilots, and flight instructors and compare weather thresholds resulting in a VNR decision
  - Identify the products and thresholds used by each group to make a VNR decision
  - Assess confidence in level in VNR decisions
    - Level of risk acceptance by each group
  - Assess impact of providing flight category inputs versus visibility numbers

WTIC – VNR Project Summary

- Status
  - Targeting start date late February to March
  - Need to schedule pilot and flight special subjects
  - **Looking for inputs on Alaska VNR days and scenarios**
    - **Ideally we could get archived weather from Alaska on "marginal" VNR days in Alaska**
    - **POC for inputs: steve.maciejewski@faa.gov**
    - Archived weather and scenarios for lower 48 nearly complete
  - Finishing coding to enable participants to perform evaluation at "test sites" and flight service stations

Wind Information at Uncontrolled Airports

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WTIC – Cameras for Wind Information

- Goals
  - Feasibility study to determine ability and accuracy of determining wind speeds, directions, gusts, and trends at uncontrolled airports using a single camera and analytics
  - Working with Harris to use existing Helios product which is a crowd sourcing optics product using cameras
  - Assess parameters for implementation, ie, camera quality, camera placement, wind sock criteria, analytics algorithm, etc.

WTIC – Other Current Projects – Rapid Fire Session

- Other Projects with Potential for Alaska
  - **Weather Information Latency Demonstrator (WILD) and Modules**
    - Provides experiential training on weather information latency
  - **PIREP Automation Options**
    - Explore capability of auto PIREP generation/reporting tools in GA
  - **Slant Ranging**
    - Technique to enhance ability to judge visibility and distances (cut pilot visibility estimate errors in half)
  - **Time Stamping**
    - Developing recommendations to standardize time stamping to enhance utility to pilots
  - **Mobile MET**
    - Recommendations to pilots and industry for weather apps
  - **Impacts on Pilot Decision Making of Nulling Latency**
    - Use forecast data to extrapolate NEXRAD to provide “current information” and assess impacts on pilots

QUESTIONS?

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