Visibility Estimation through Image Analytics

Intermountain West Aviation Weather Safety Workshop

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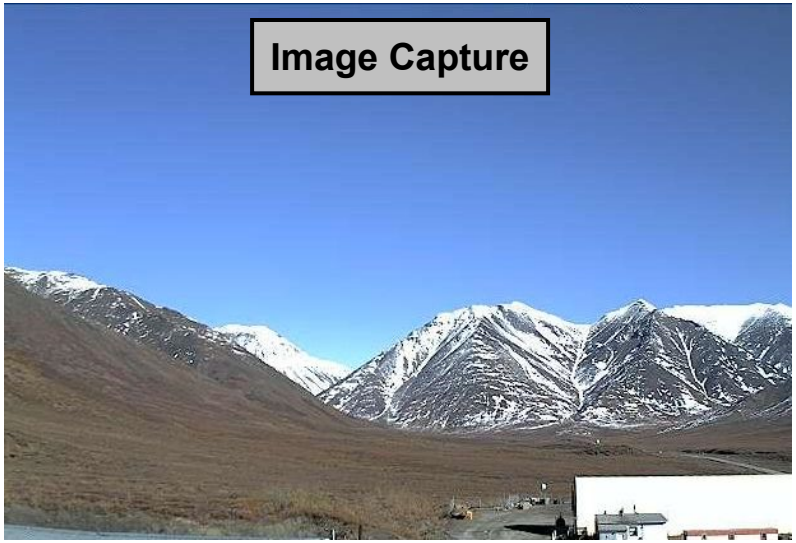
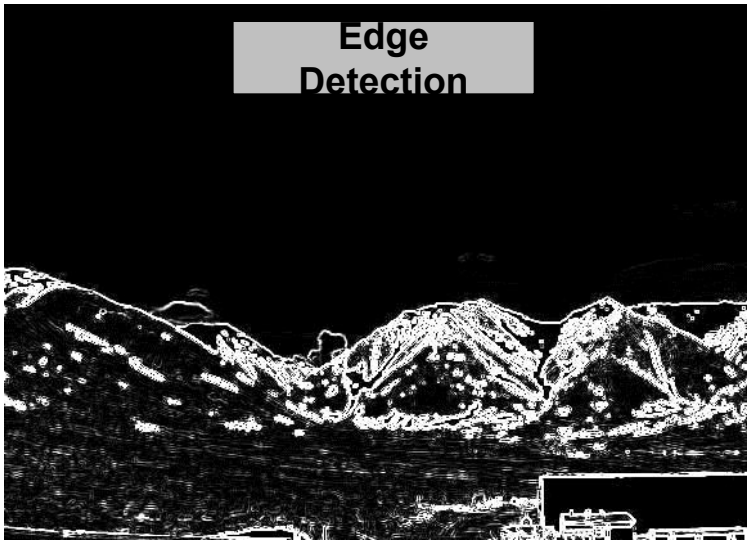
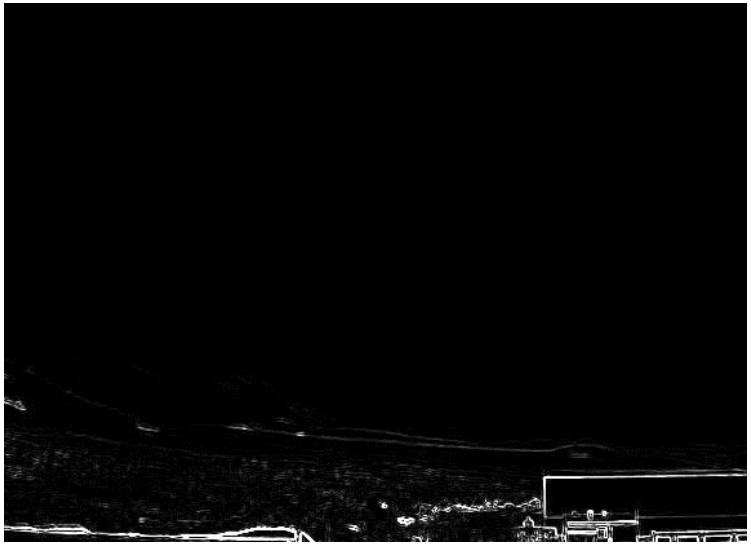
Using Edges for Visibility Estimation



10+ miles



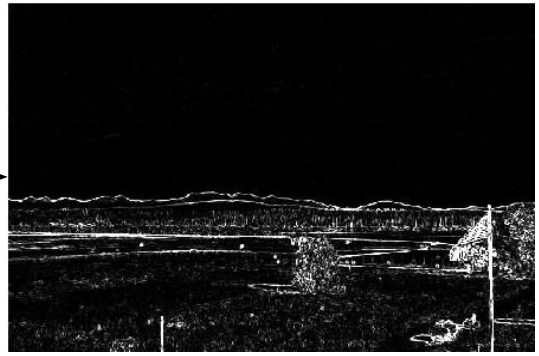
¼ mile

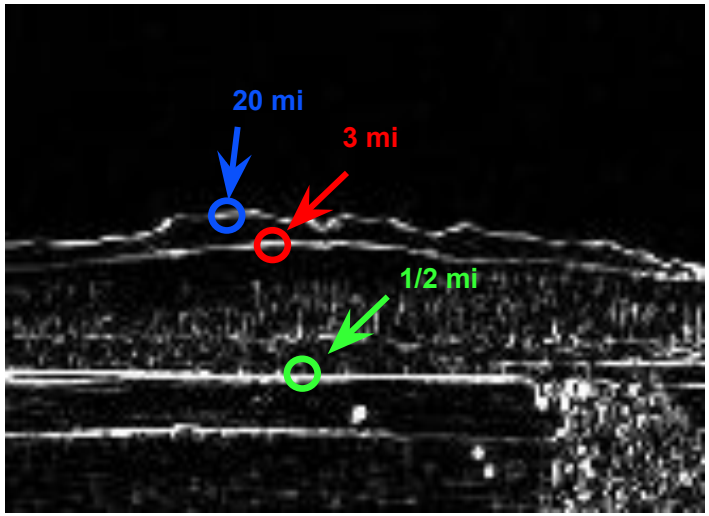


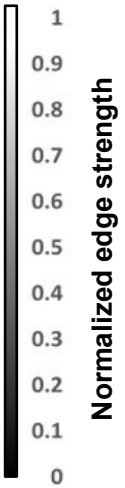
Chandler Shelf, AK

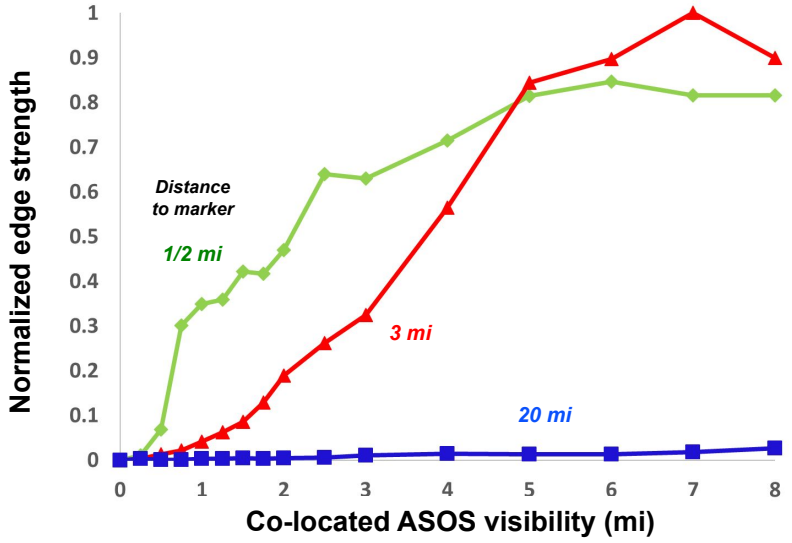
Technical Concept: Relate Image Edge Strength to Visibility

Edge Detection Algorithm









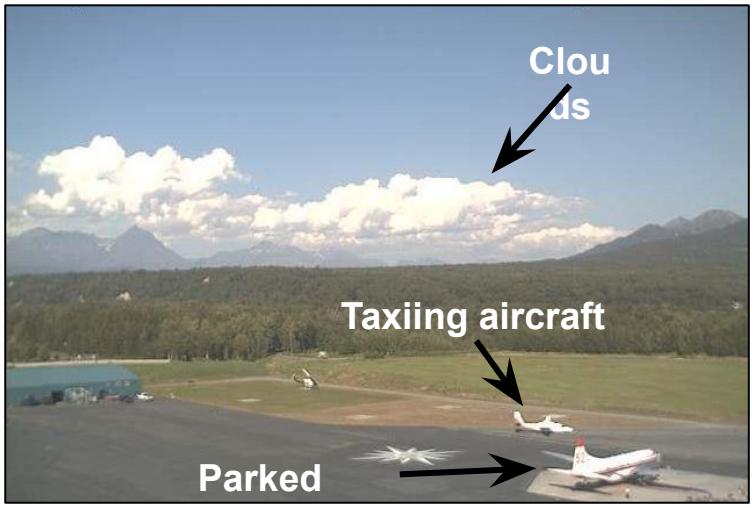
Edge strength is a function of marker distance and visibility

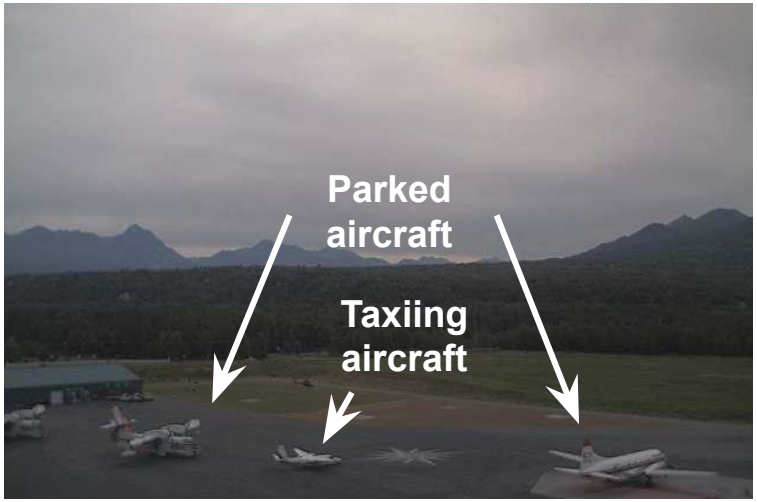
ASOS = Automated Surface Observing System

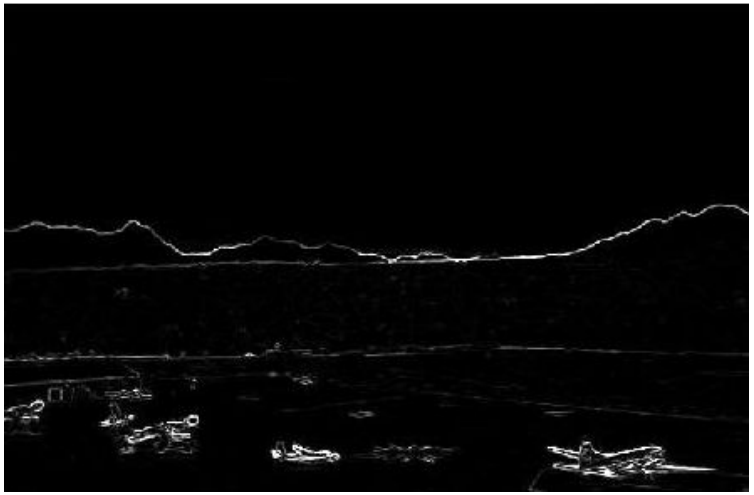
Challenges using Edge Detection

- Generating a translation function from edge strength for every marker and every camera to visibility would be daunting
  - Method must be portable to scenes without truth source
- Transient objects create edges that can corrupt the results
  - People, vehicles, aircraft, clouds
- Seasonal variation in scene can alter available markers
  - Winter vs summer
- Low sun angle creates solar glare
- Only available in daylight conditions

Example of Transient Edges
Palmer AK (Northeast)



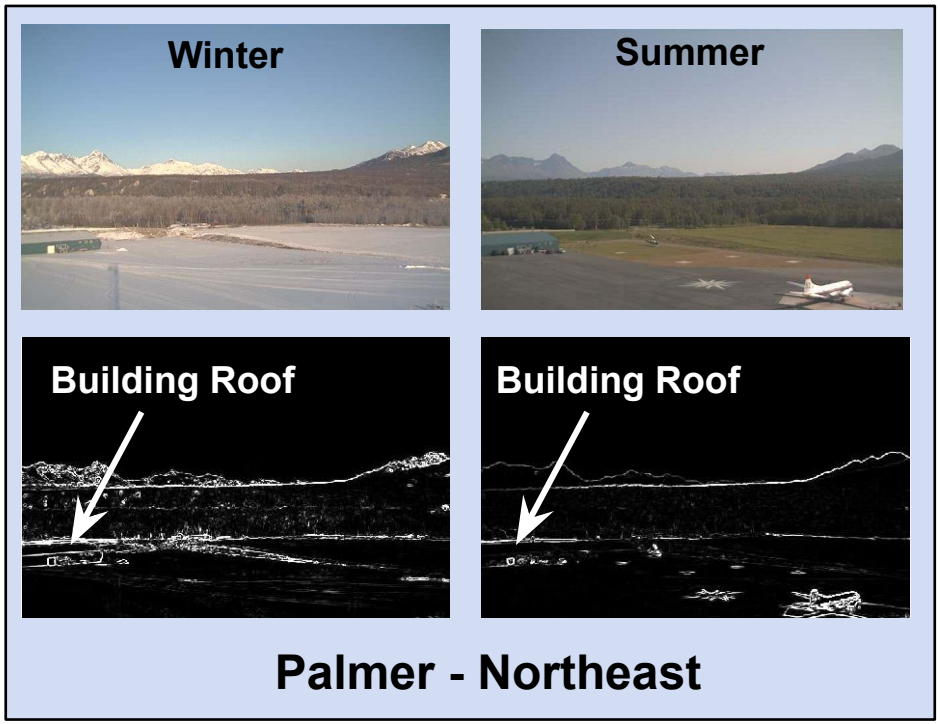


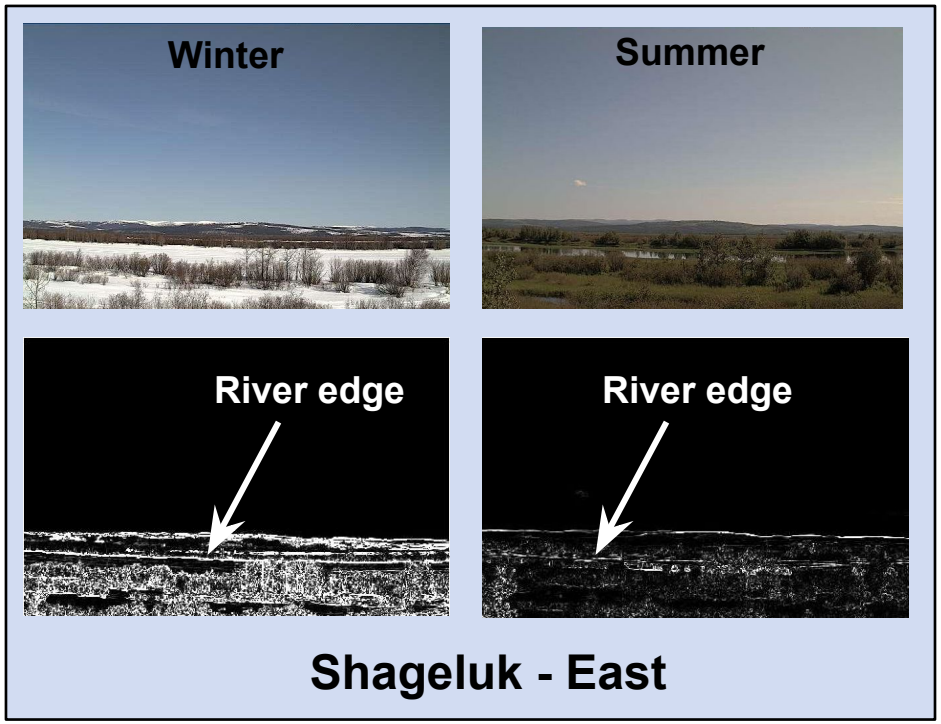


June 1, 2015

July 4, 2015

Seasonal Variation in Clear Day Images





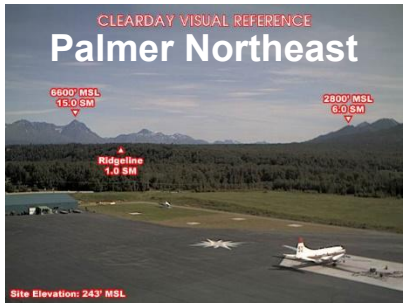
Snow cover has a significant impact on the edges in the image

Mitigations

- Generate a running composite image over a several day period
  - Removes variability in image due to transient objects
  - Captures reliable edges for normalizing edge strengths
  - Captures seasonal variation in reliable edges
  - Reduces impact of extended periods of low visibility

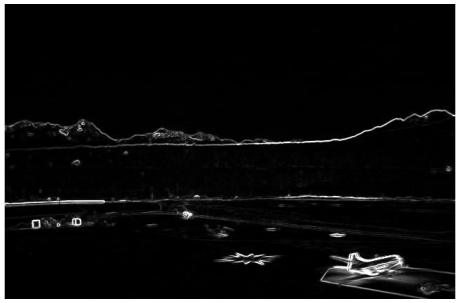
- Evaluate image using entire scene not specific markers
  - Automatic identification of “edges of importance” to serve as benchmarks (e.g., mountains, buildings, roadways)
  - Generate a single metric for each image representing the collective image edge strength

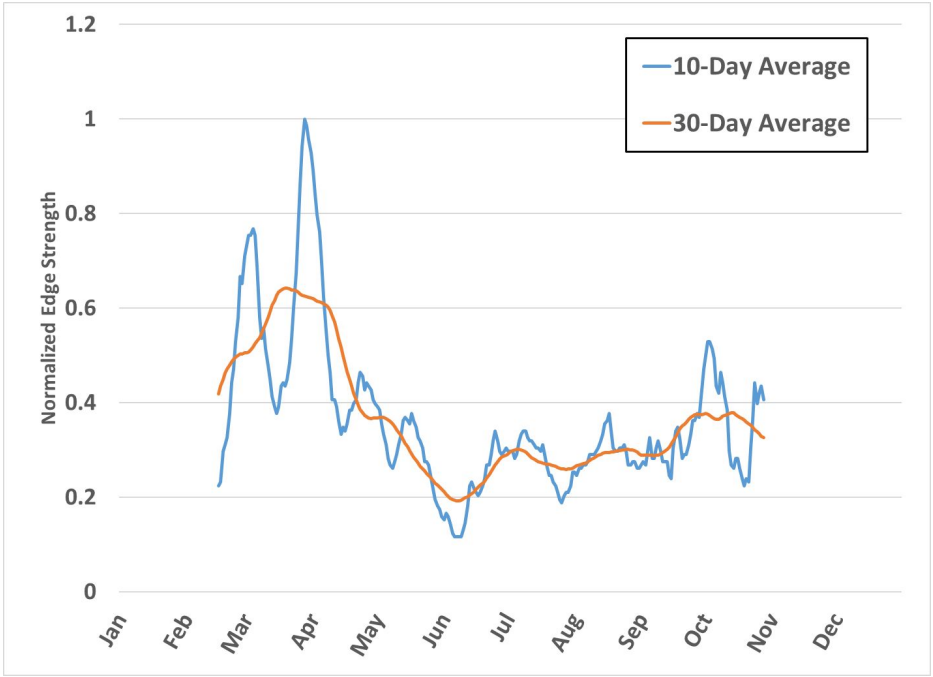
Composite Image Generation



February Composite

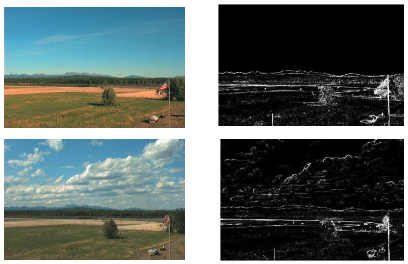
May Composite





10 day window selected as compromise for composite generation

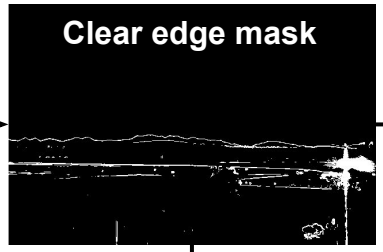
VEIA Flow Chart



History of 'Clear' Images

Composite Image Generation

Edges of Interest Extraction



Edge Detection Algorithm

Current Image

10+ miles

GreyScale Conversion

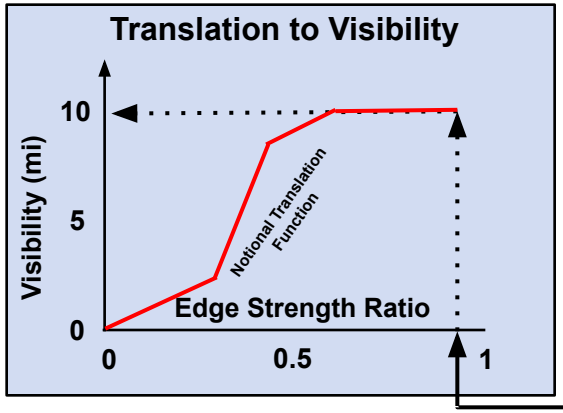
Edge Detection Algorithm

\+

−

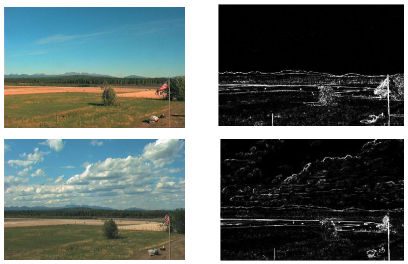
Current edge strength

Clear edge strength



Edge strength ratio

VEIA Flow Chart



History of 'Clear' Images

Composite Image Generation

Edges of Interest Extraction

Clear edge mask

Edge Detection Algorithm

Current Image

3 miles

GreyScale Conversion

Edge Detection Algorithm

+

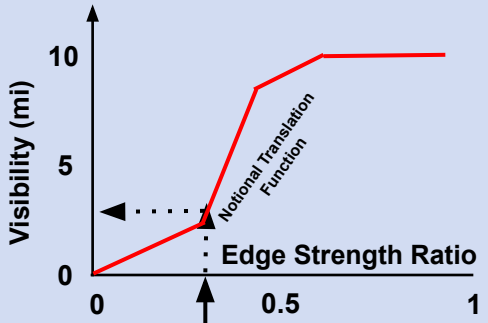
−

Current edge strength

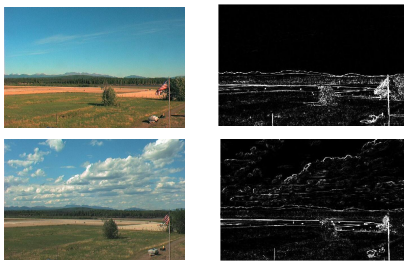
Clear edge strength

Edge strength ratio

Translation to Visibility



VEIA Flow Chart



History of 'Clear' Images

Composite Image Generation

Edges of Interest Extraction

Clear edge mask

Edge Detection Algorithm

Current Image

½ mile

GreyScale Conversion

Edge Detection Algorithm

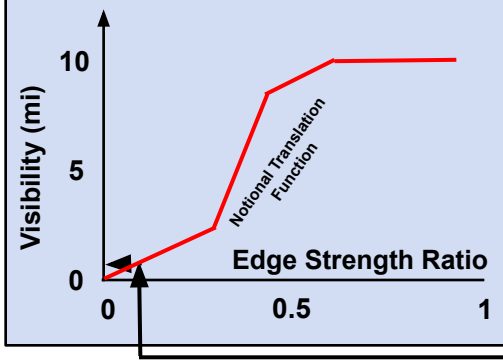
+

−

Current edge strength

Clear edge strength

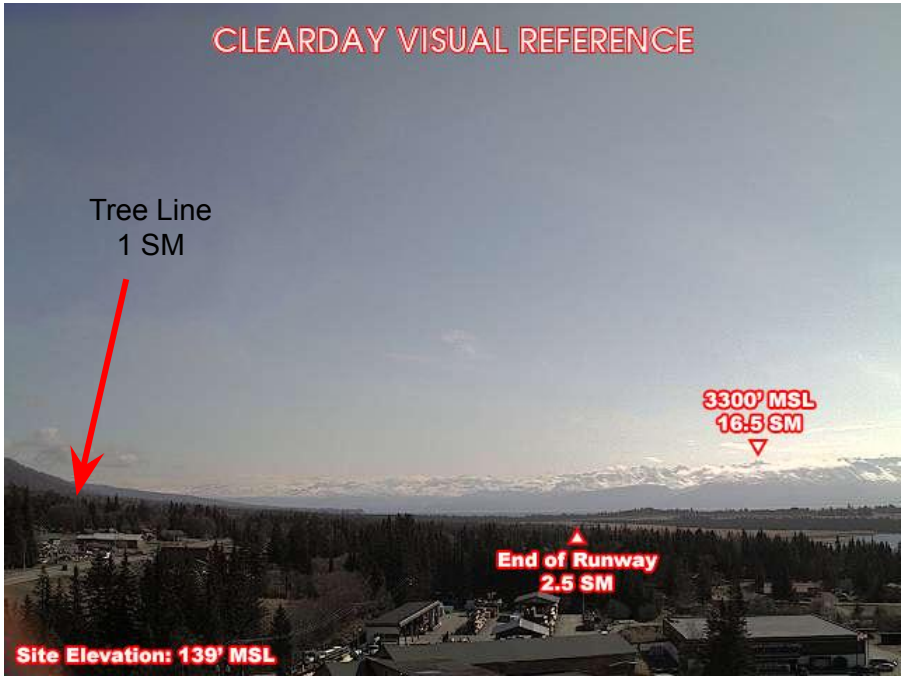
Translation to Visibility



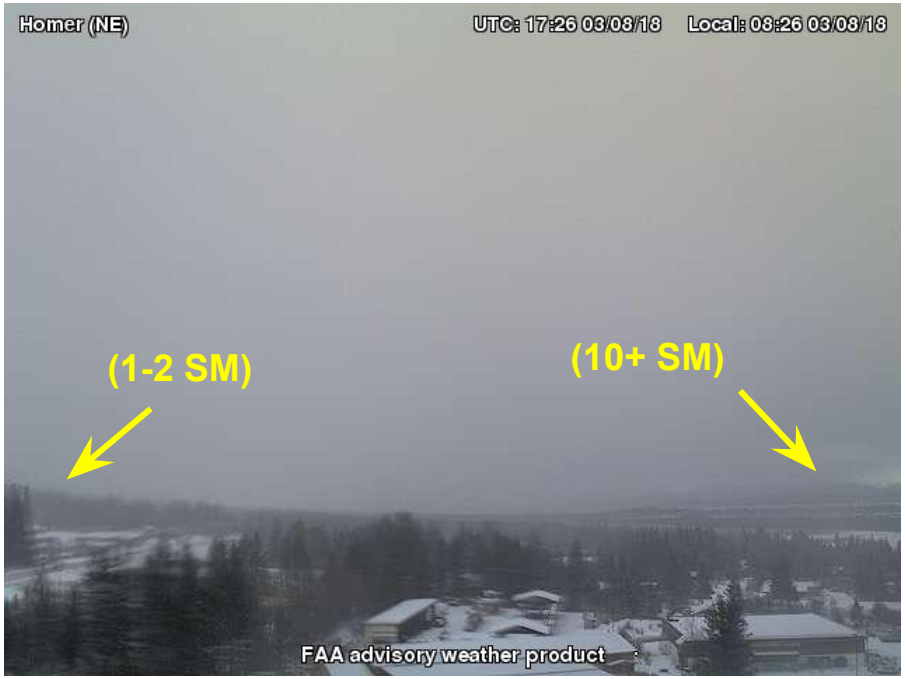
Edge strength ratio

Example Observed Reduced Visibility Day

Homer, Alaska (Northeast)



Clear Day



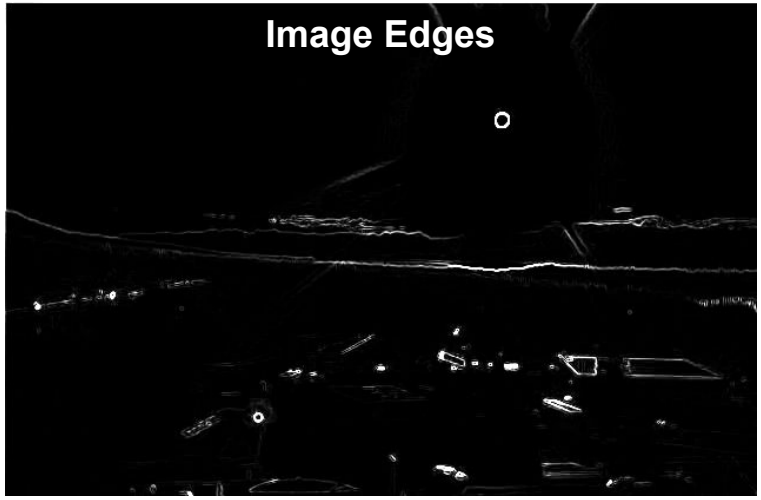
Now

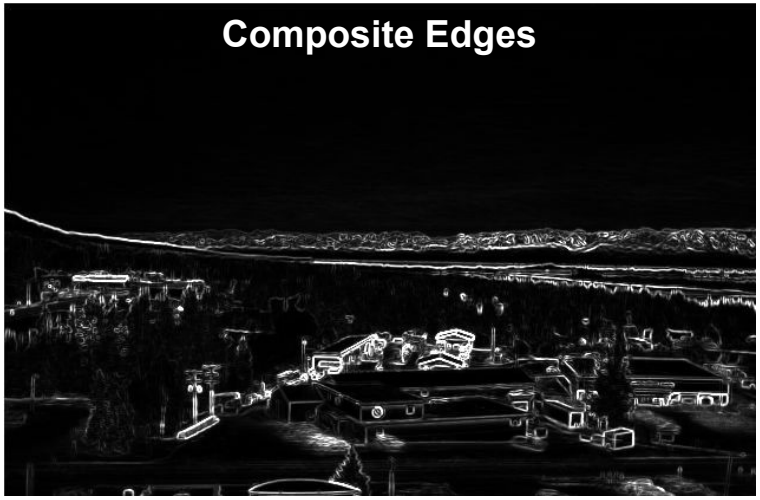
- A large number of markers are required to accurately identify the visibility in a scene
- Visibility can vary significantly within single scene (prevailing visibility)

Accurately estimating the visibility takes months of experience with specific local knowledge

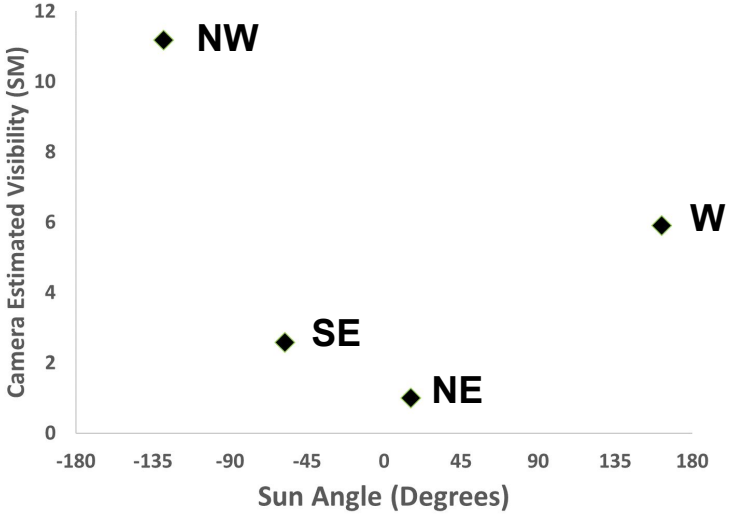
SM = Statute Miles
MSL = Mean Sea Level

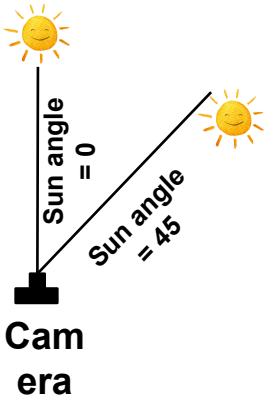
Example Solar Glare on Camera Imagery

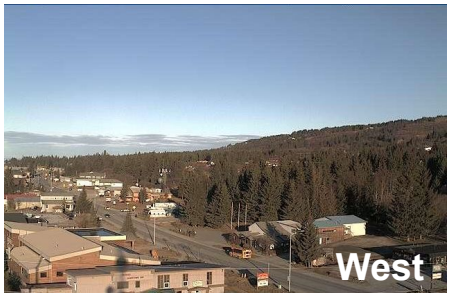




Solar Glare Impact on Camera Visibility







Solution: Implement weighting scheme based upon sun angle and agreement between co-located cameras

Combining Multiple Cameras into a Site Estimate

Single Camera VEIA

Single Camera VEIA

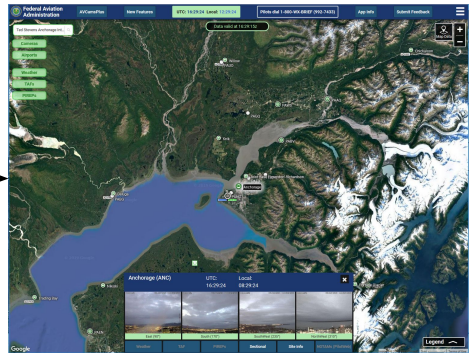
Single Camera VEIA

Single Camera VEIA

Site Combiner VEIA

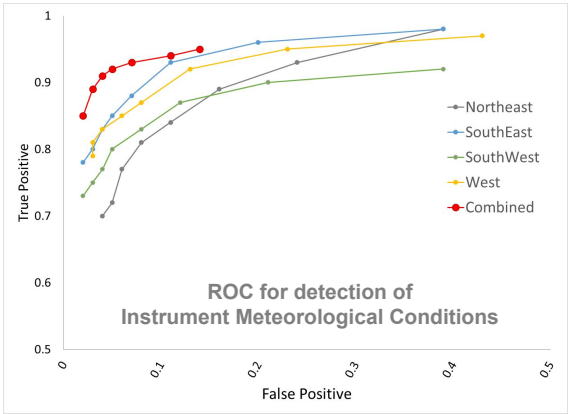
Visibility

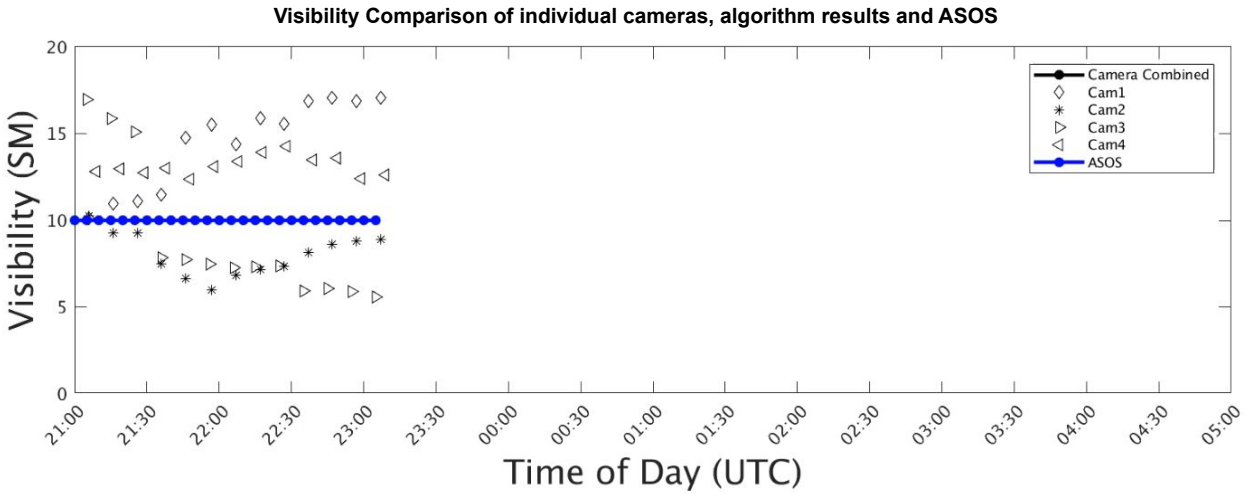
WXCAMS+



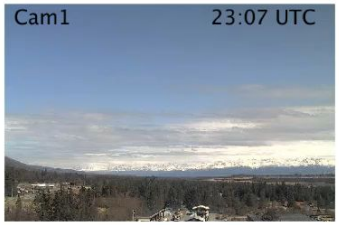
- ‘Single Camera’ and ‘Site Combiner’ hosted on WXCAMS+ System
- Each site can host anywhere from two to four cameras

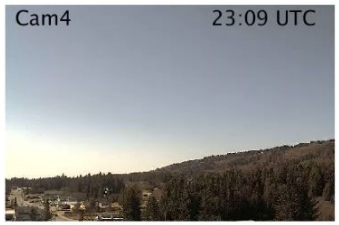
Improving Performance Using Multiple Cameras



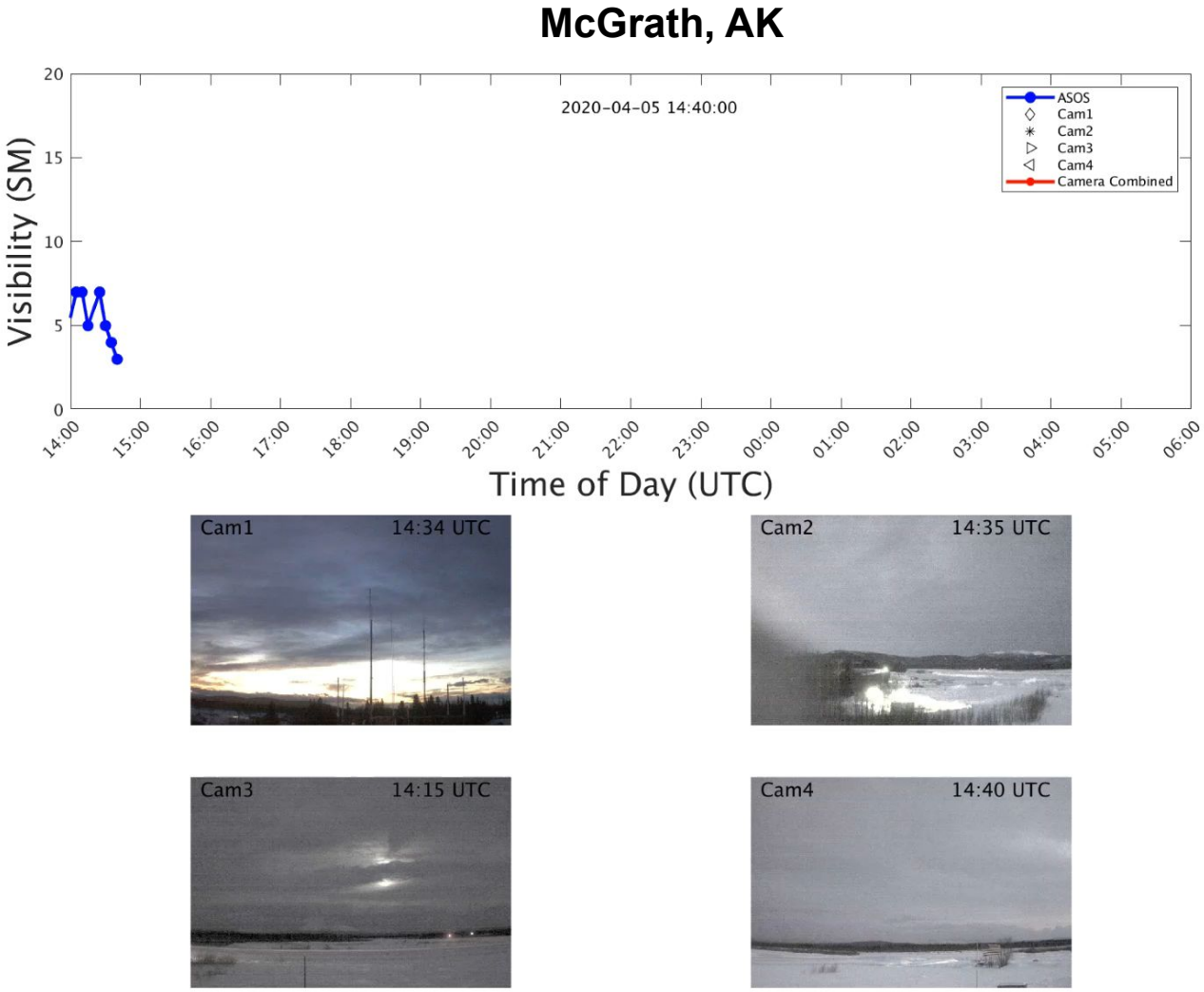


Homer, AK



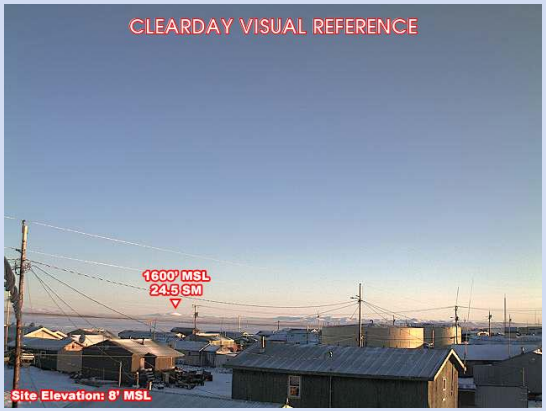


Example of Highly Variable Conditions

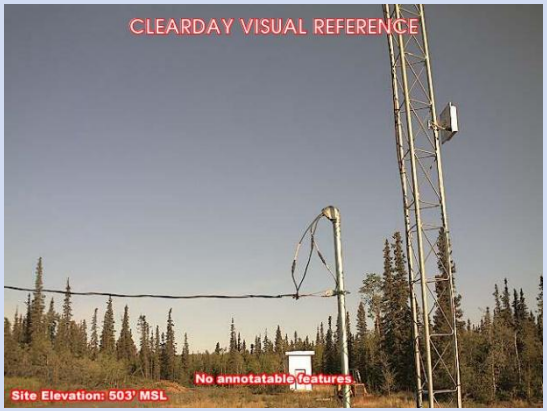


Scenes and Camera Orientations Impacting VEIA Performance

Power Lines, Towers and Foreground Clutter

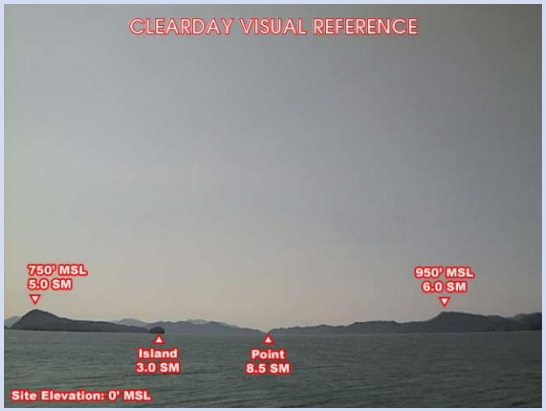


Kivilina, AK East

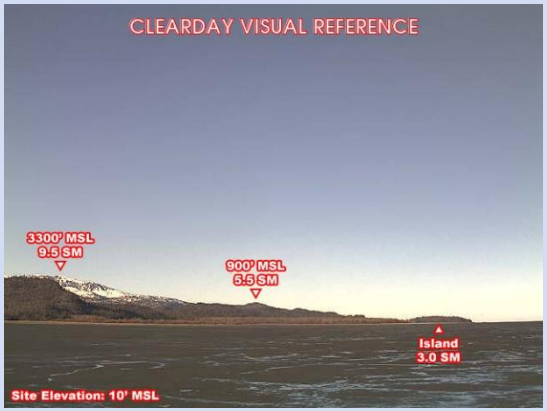


Minto, AK Northwest

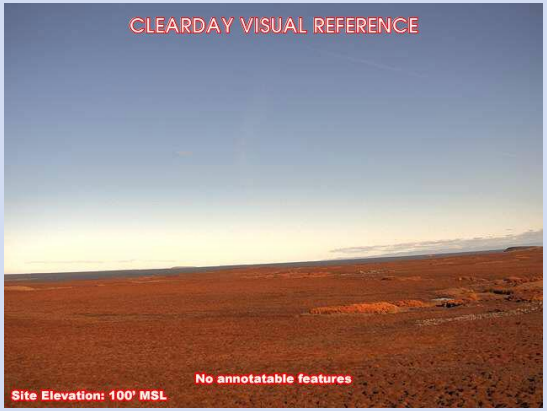
Open Water, Limited Foreground Objects, and Disproportionate Sky Views



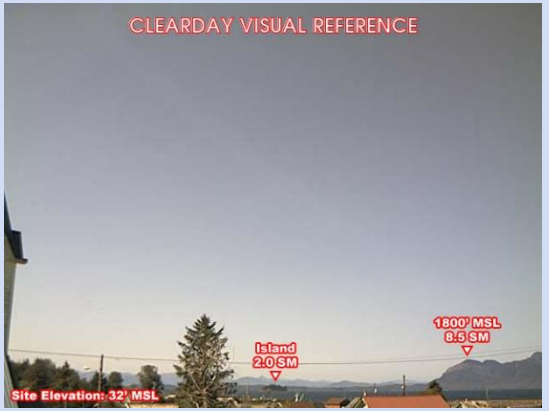
Misty Fjords, AK South



Bradley Lake, AK South



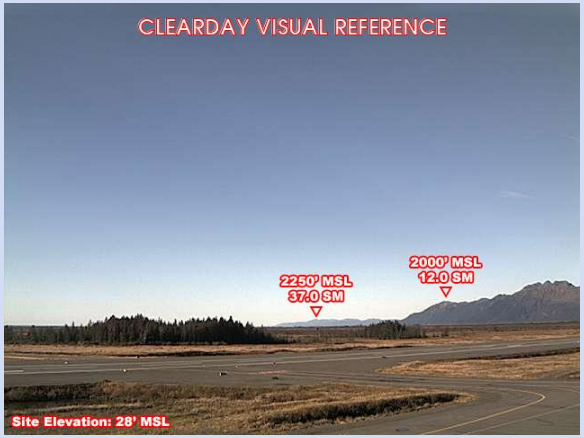
St. Michael, AK Northeast



Metlahatla, AK West

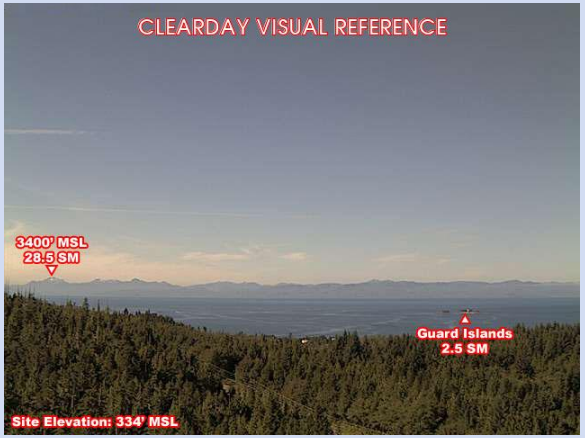
Transient Camera Issues Impacting VEIA Performance

Ice Blockage



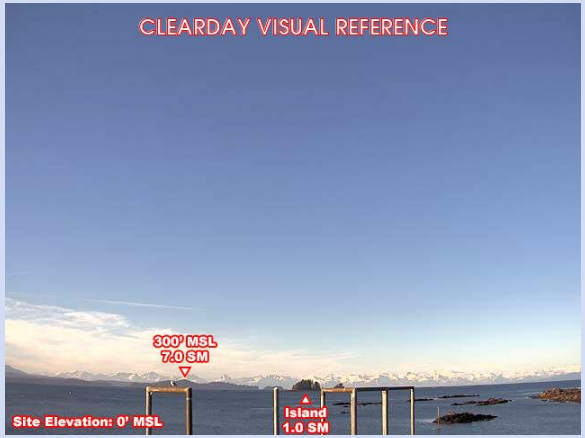
Cordova, AK Southwest

Mounting Failures



Point Higgins, AK

Human Interference



Kake, AK West

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