FAA Aviation Weather Research Program

Alaska-specific Product Development

Presented to: The Alaska Weather and Aviation Workshop

By: Jenny Colavito

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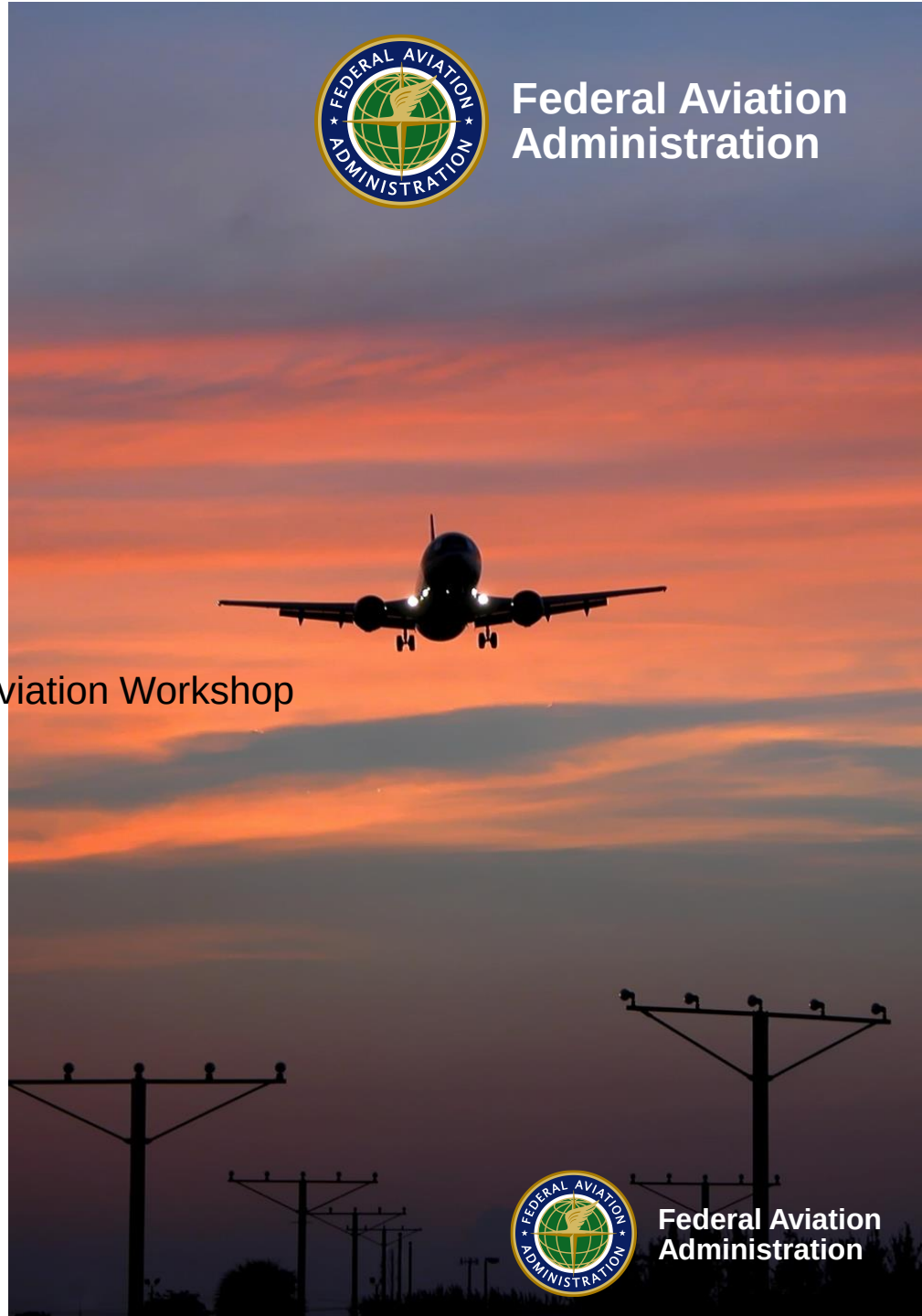
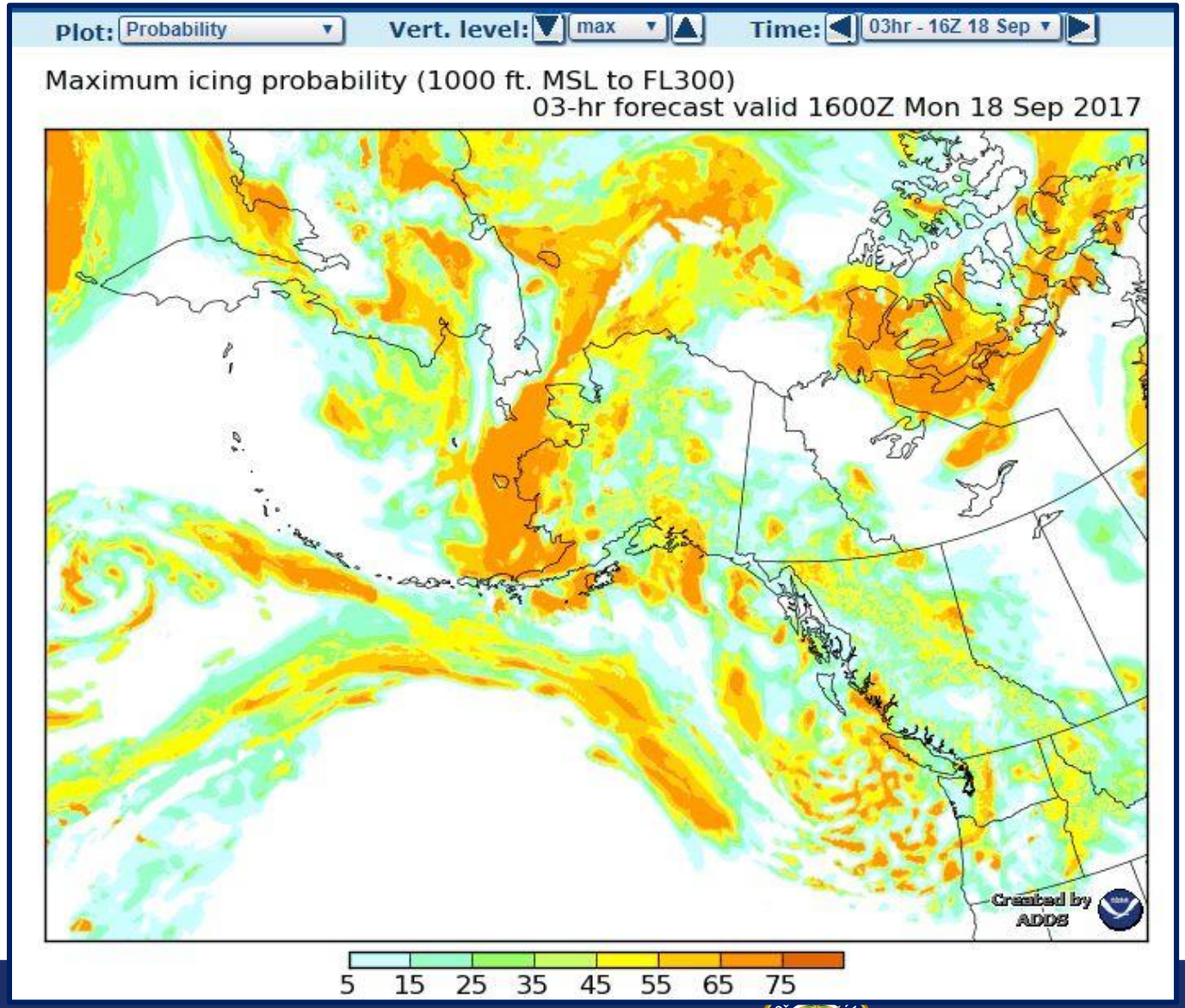


AWRP
Alaska-specific Product Development

- **Icing – Icing Product Alaska (IPA)**
- **Turbulence - Graphical Turbulence Guidance (GTG) Alaska Forecast**
- **Ceiling and Visibility (C&V)**
  - C&V Analysis for Alaska (CVA-AK)
  - Weather Camera estimates of visibility

Icing Product Alaska Probability



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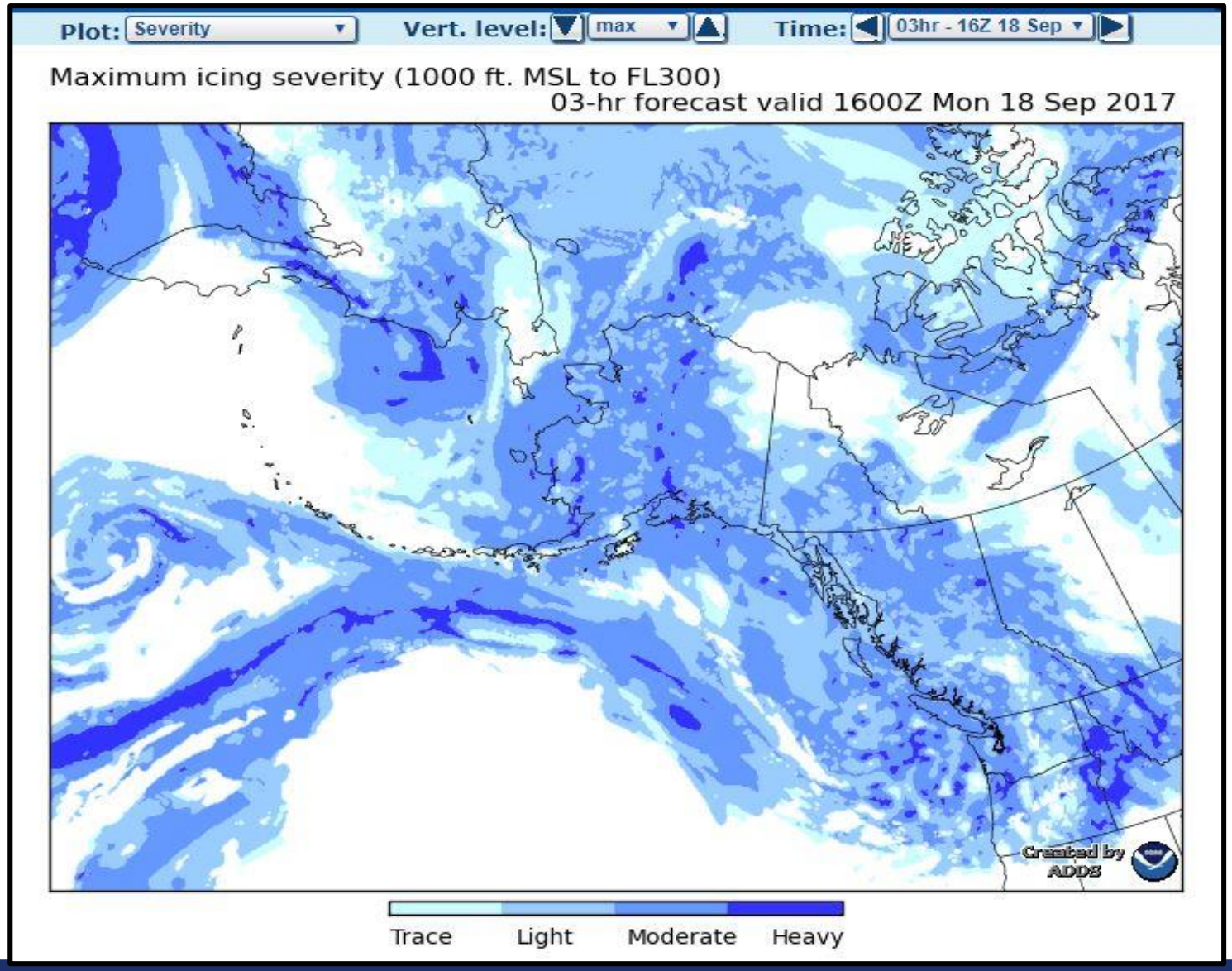
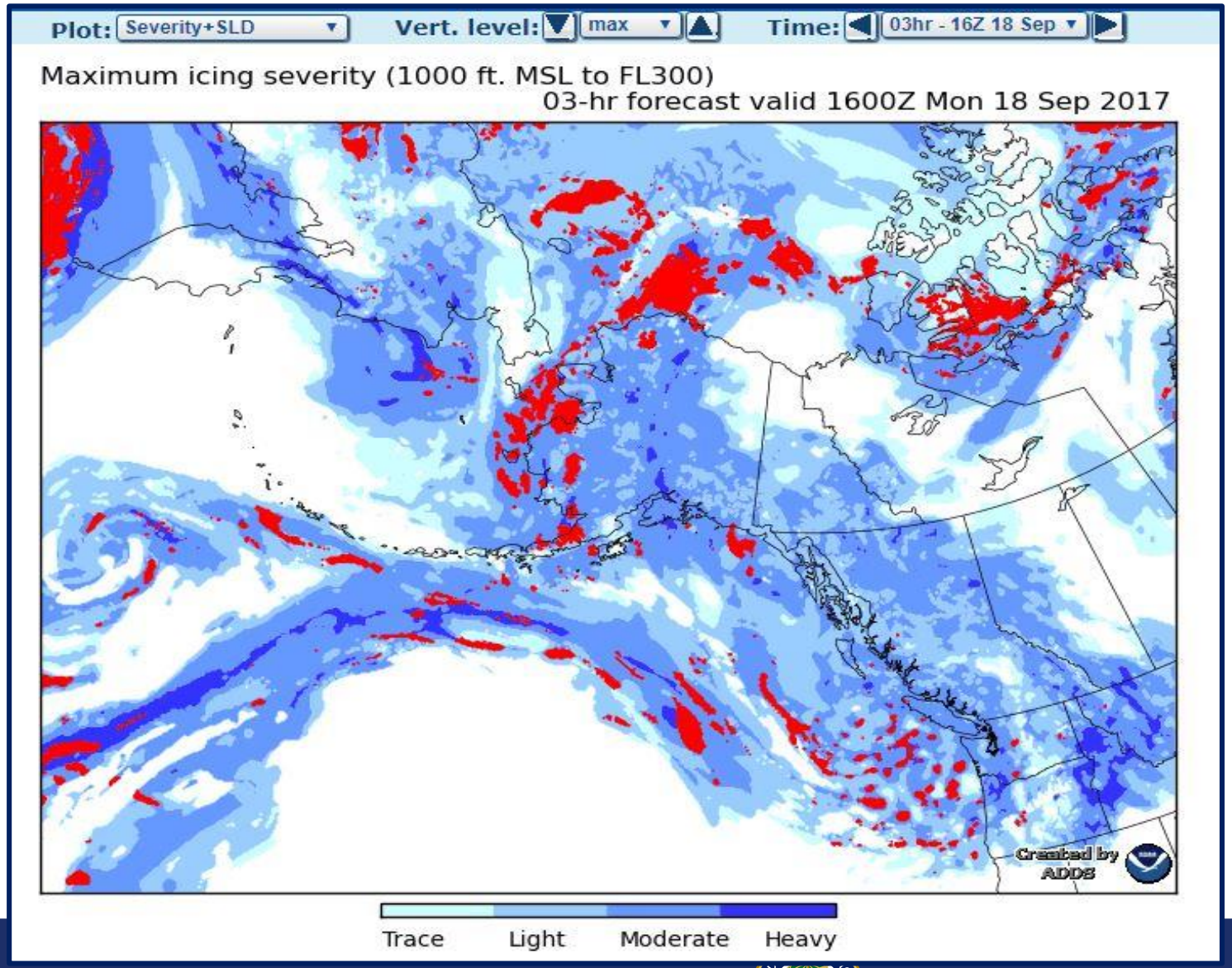
Icing Product Alaska (IPA) Overview

- **IPA is currently experimental**
  - AAWU evaluating
  - Research to operations plan being developed to include Concept of Operations
- **IPA Description**
  - Forecasts to 21 hours (and going to 39 hours)
  - 13 kilometer horizontal spacing with 1000 feet vertical resolution to 30,000
  - Automated product issued hourly
  - Model forecasts combined with surface observations, satellite data, and pilot reports
- **Assessment Results**
  - IPA outperforms other gridded forecasts when compared to observations
  - IPA increases skill when forecasting moderate or greater icing

IPA Severity



IPA Severity and Supercooled Large Drops



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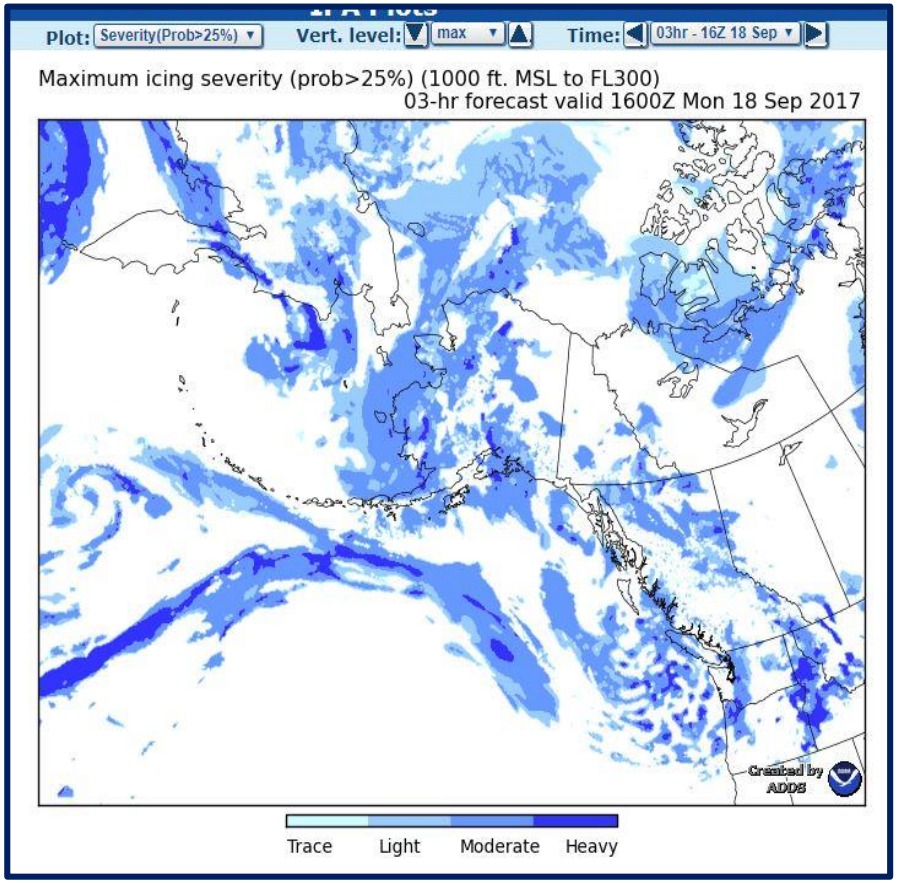
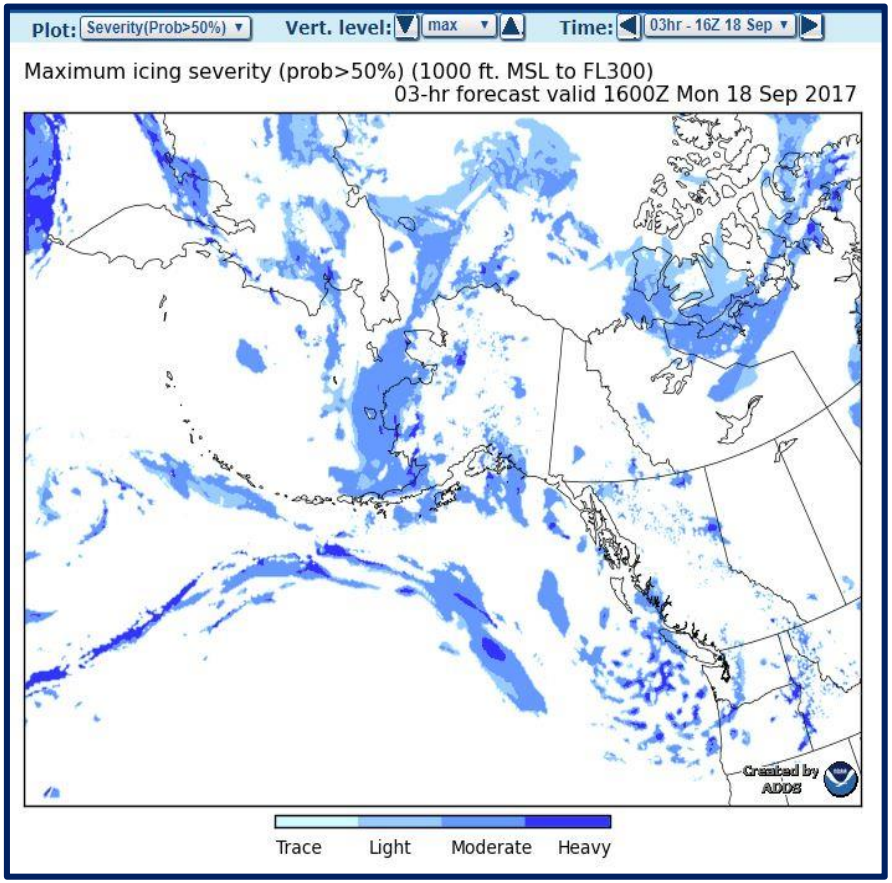
IPA Severity with Probability

- IPA-F Severity Probability >25%



- IPA-F Severity Probability >50%

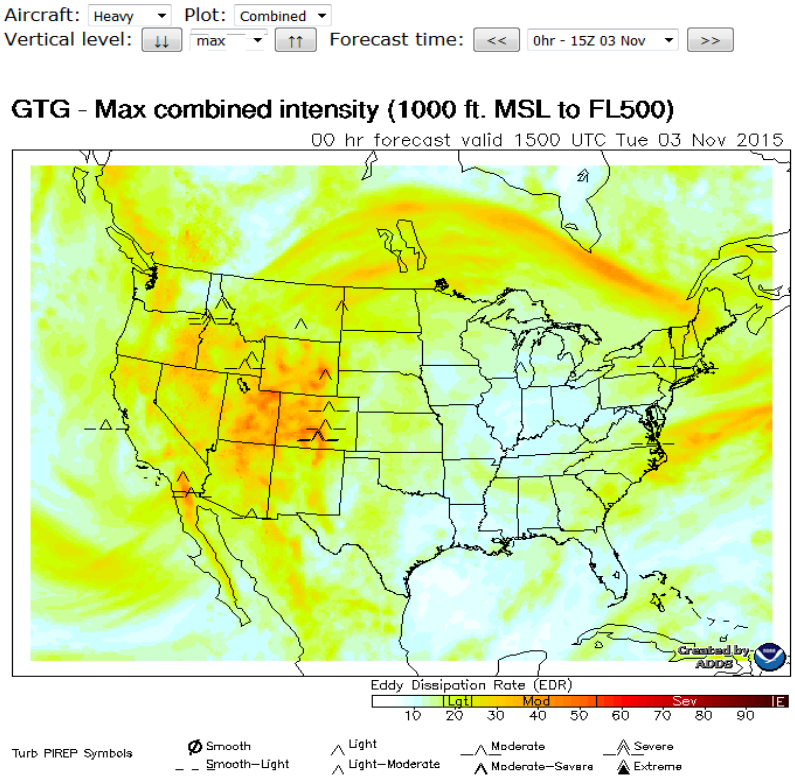


IPA Future Research

- **Future Research**
  - Combining polar orbiting and geostationary satellite
  - Adding radar data
  - Using finer resolution model (3-kilometer horizontal spacing)

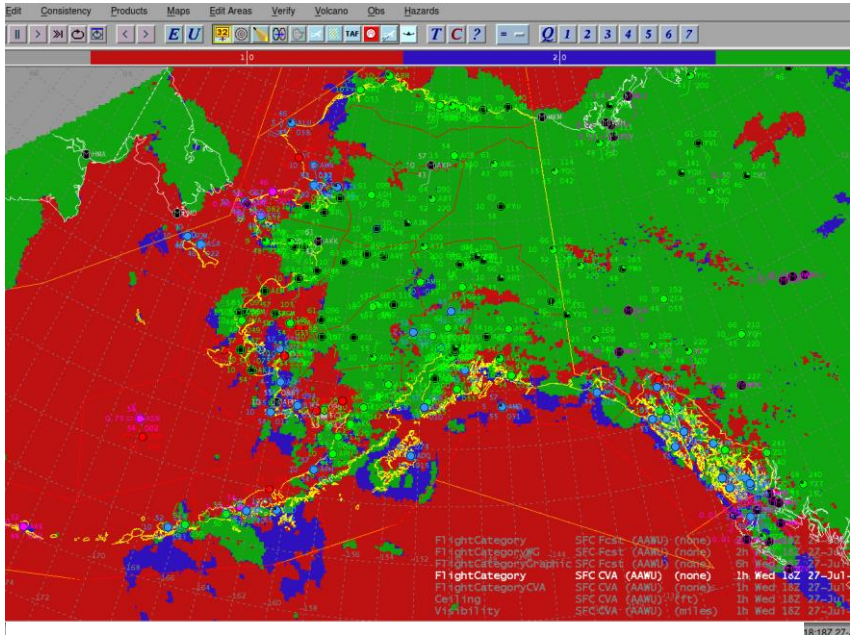
Graphical Turbulence Guidance (GTG) Alaska Forecast

- Current CONUS GTG3:
  - 0-18 hours, updated hourly
  - WRF-RAP-based
  - All flight levels 1000 ft – FL450
- Development of an Alaska HRRR-based GTG begun early 2000's
- Initial product used University of Fairbanks version of HRRR model
- Because of the uncertainty of whether U-Fairbanks version would be available operationally, development shifted to using WRF-RAP in FY14
- In FY15, focus shifted to GTG-Global
- Uncertainty in where a GTG-AK would run and who/how it would be used, plus increasing emphasis on GTG-Global, resulted in no work on GTG-AK in FY16 and FY17
- Work could be resumed, but funding continues to be an issue



CONUS GTG CAT+MWT All Levels

Ceiling and Visibility Analysis for Alaska (CVA-AK)



Screenshot of CVA-AK flight category analysis with METARS overlaid, as seen on AAWU workstation

- Gridded analysis of ceiling, visibility, and flight category
- Developmental prototype being evaluated by AAWU
- Planned technology transfer to RTMA

- Current version assimilates:
  - Calibrated RAP model
  - ASOS/AWOS surface stations
  - GOES satellite
- In development, assimilate data from:
  - Polar-orbiting satellites
  - Visibility estimates from weather cameras

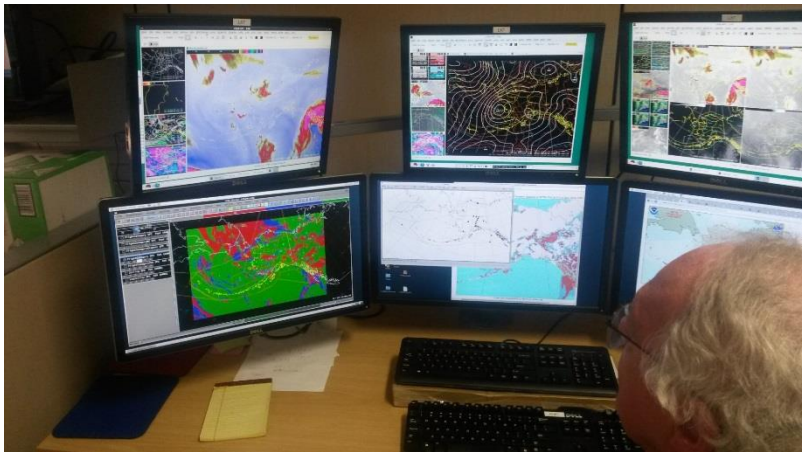


Image of AAWU forecaster, David Barber, using CVA-AK in bottom left display at workstation

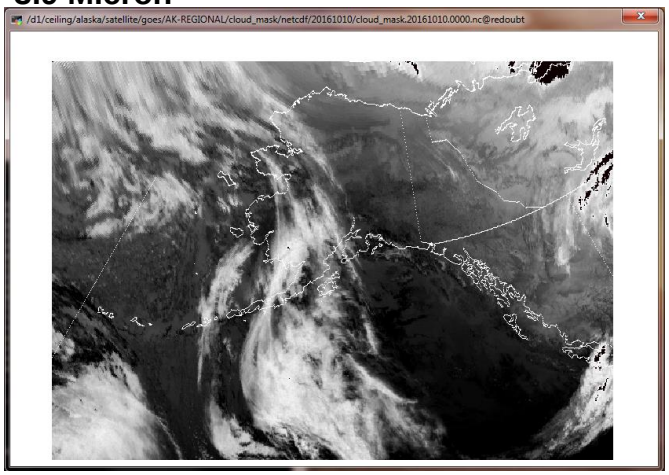
CVA-AK Development Schedule

- V1.0 June 2016: RAP model + METAR
- V1.5 June 2017: Calibrated RAP model + METAR
- V2.0 Oct 2017: Calibrated RAP + METAR + GOES Cloud Mask
- V2.5 Oct 2018: Calibrated RAP + METAR + GOES/POES Cloud Mask
- V3.0 2019: Calibrated RAP + METAR + GOES/POES Cloud Masks + FAA WebCam observations

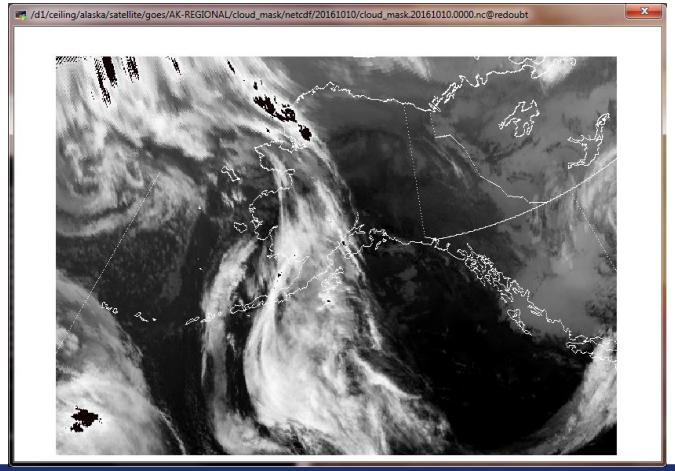
CVA-AK Development, V2.0 *Current Version*

Calibrated RAP + METAR + GOES Cloud Mask

3.9 Micron

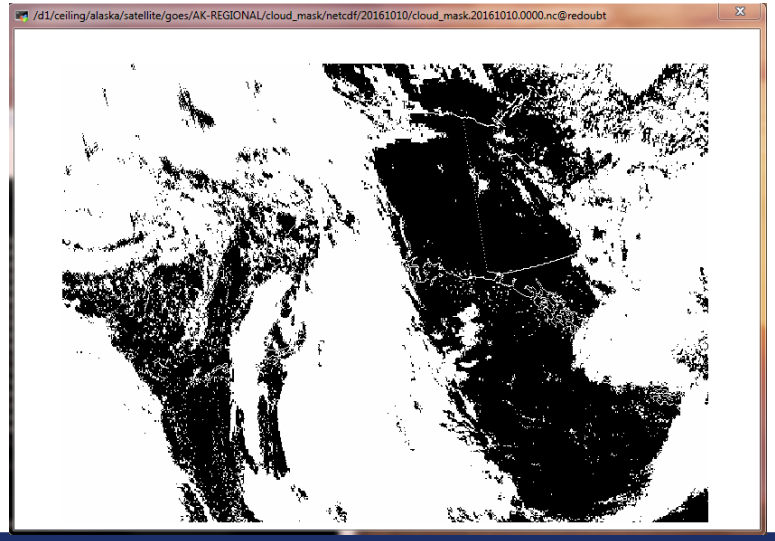


11 Micron

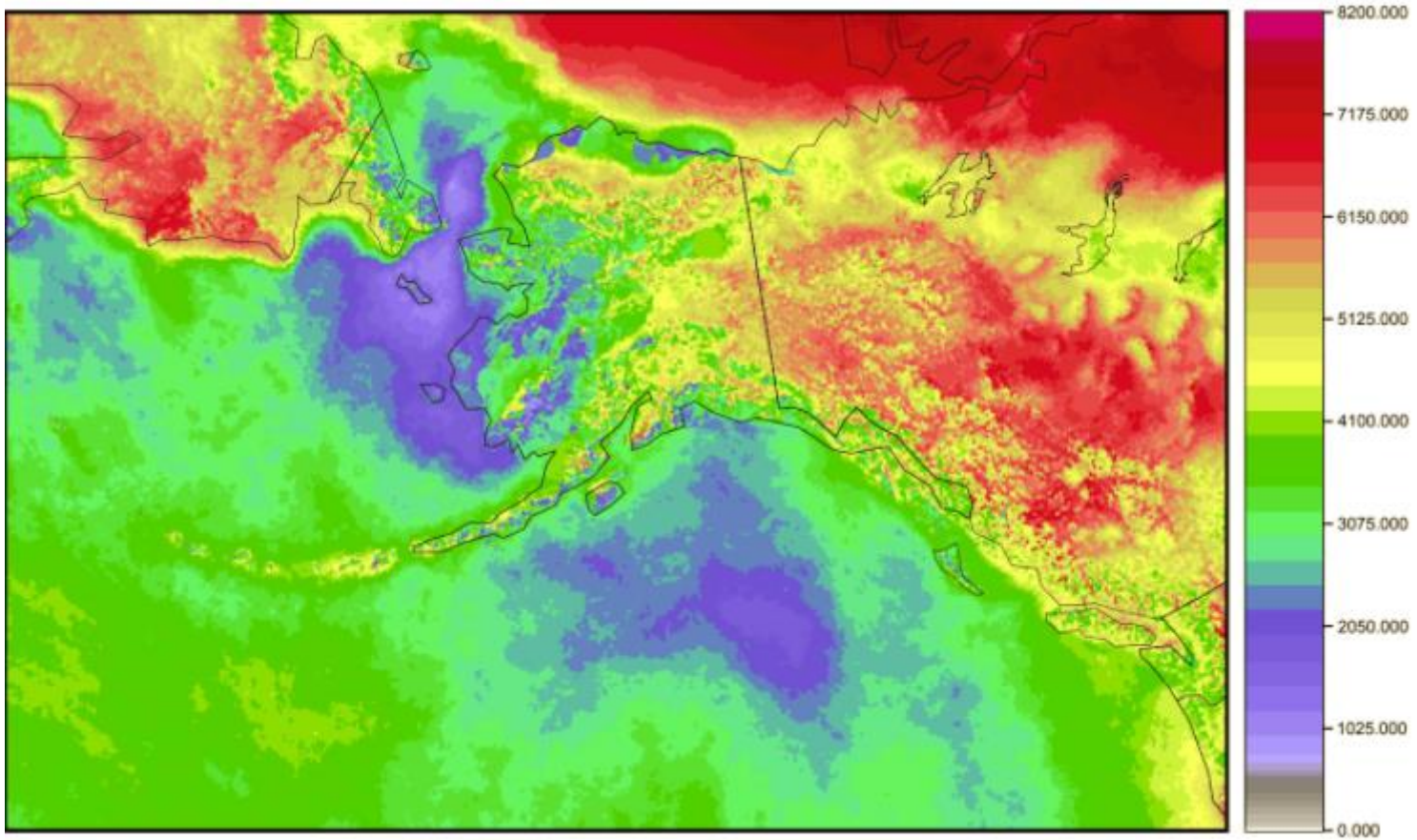


- Cloud mask algorithm runs on GOES 3.9 and 11 micron channels, a gridded field of cloud/clear areas are identified.
- Is used to ‘clear’ the ceiling only
- Does not affect the visibility field
- Preliminary evaluation shows largest impact of cloud mask over oceanic regions

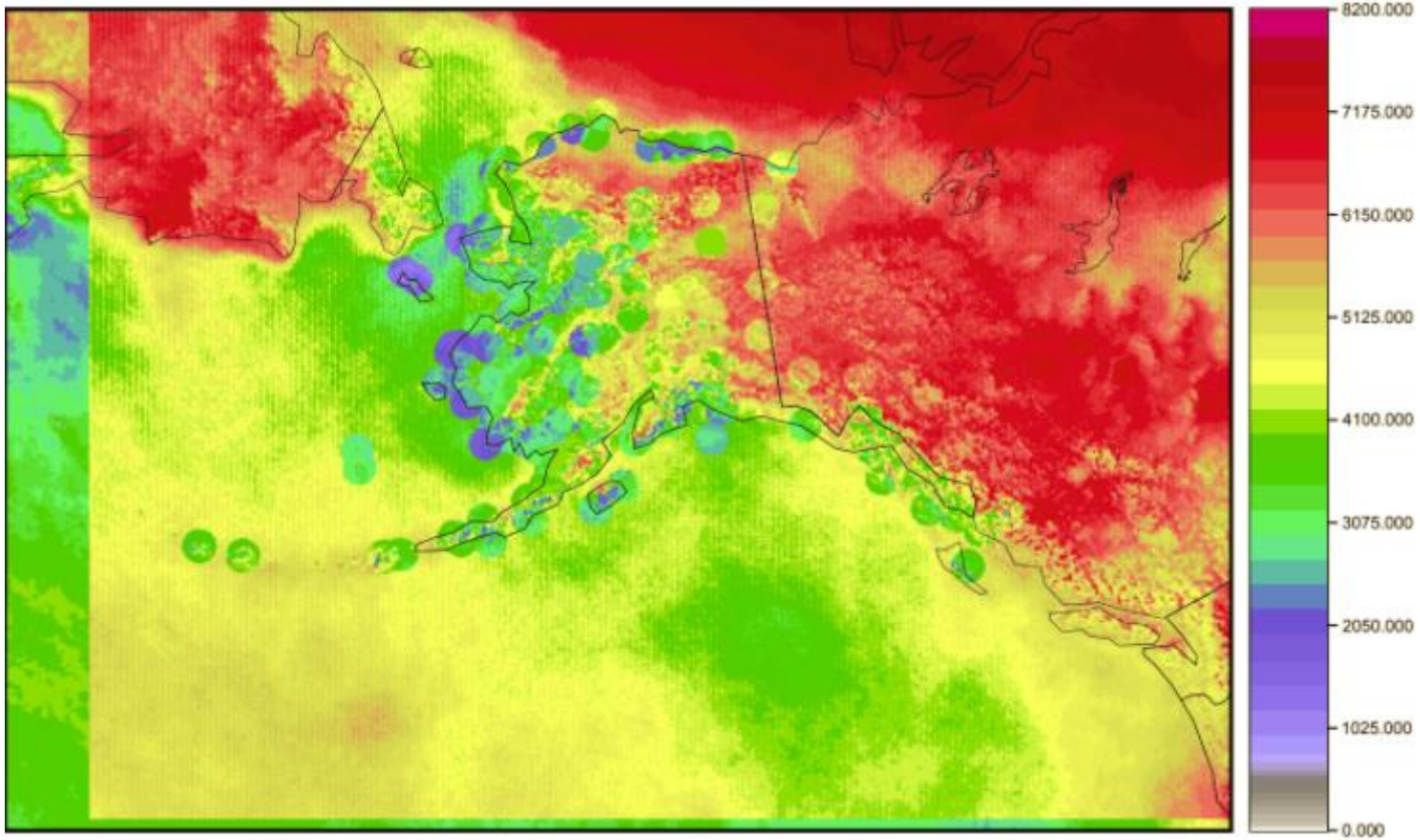
Resultant Cloud Mask



V1.0 Average Ceiling Dec 2017



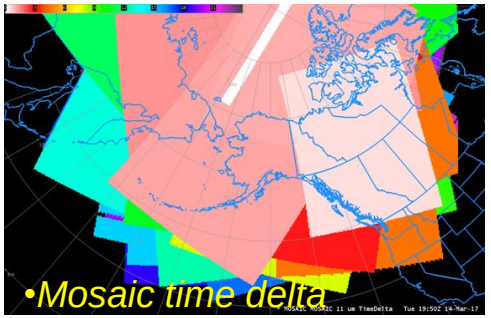
V2.0 Average Ceiling Dec 2017

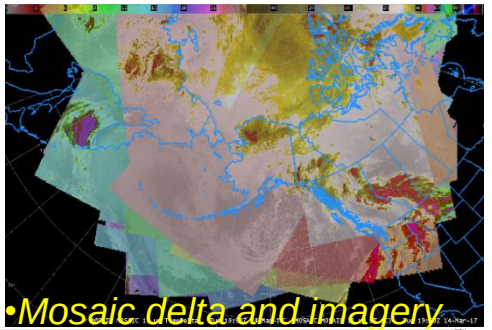


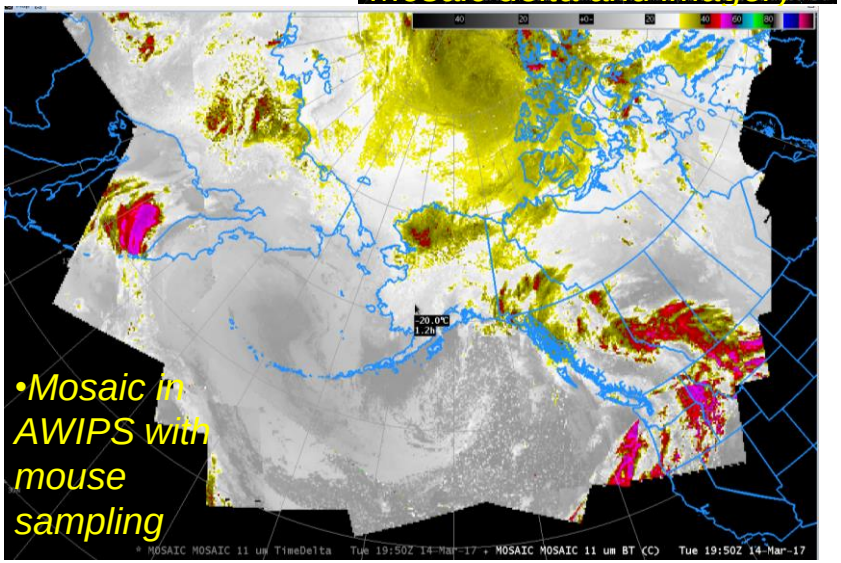
CVA-AK Development, V2.5

Calibrated RAP + METAR + GOES/POES Cloud Mask

- **Benefit:** POES imagery has higher spatial resolution at high latitudes
- Mosaic software obtained from Geographic Information Network of Alaska (GINA)
- Data is being archived → apply cloud mask (as with GOES)
- Swaths with higher latency are weighted less
- Oct 2018: to be running live at AAWU for evaluation





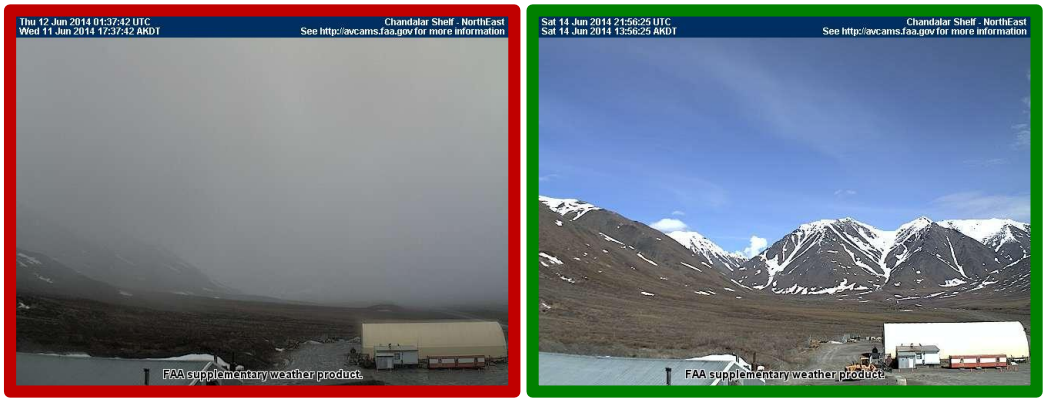


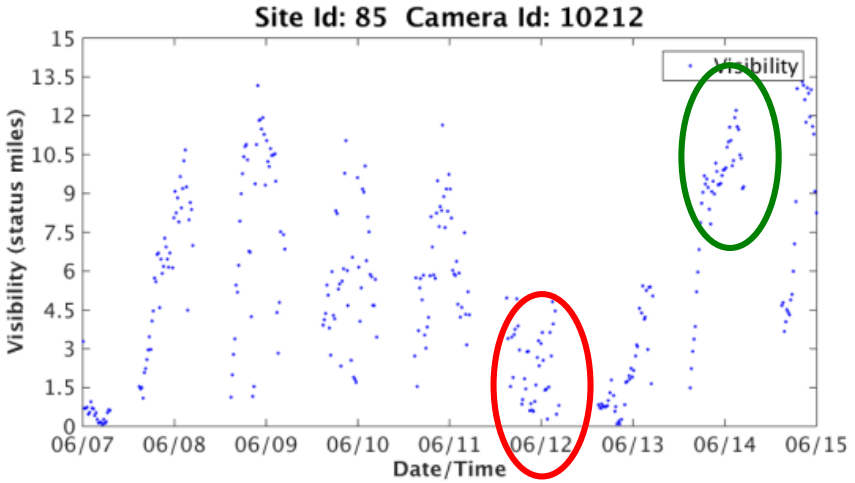
CVA-AK Development, V3.0

Calibrated RAP + METAR + GOES/POES Cloud Masks + FAA WebCam observations

- Visibility retrieval software in development
  - Edge detection & machine learning
  - Collaboration with WTIC program
- Plan to begin testing and blending camera visibility estimates into the CVA-AK starting 2019.

Alaska CVA-AK Flight Category product, as seen on developmental workstation (NCAR)





Example of the current capability to generate visibility estimates at the Chandalar shelf site. This subjectively shows the algorithm correctly identifying a clear day, and a day of low visibility.

Camera Visibility Algorithm Flow

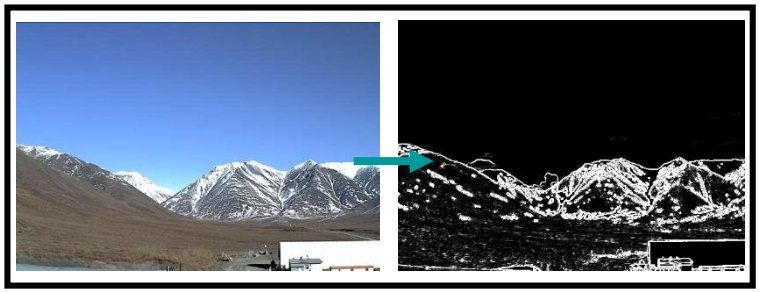


Image Capture

Edge Detection

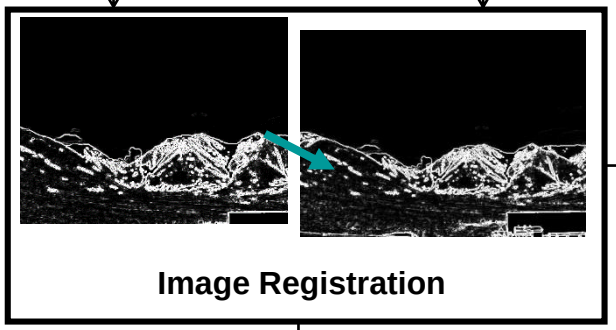
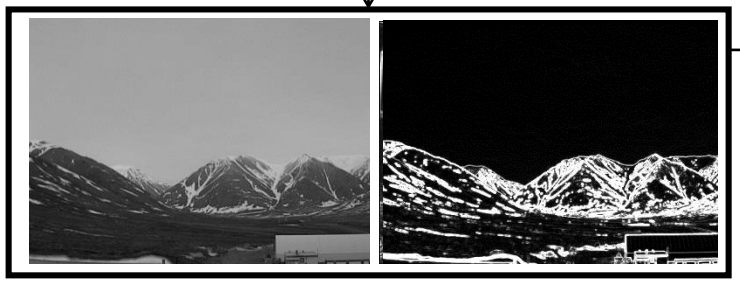
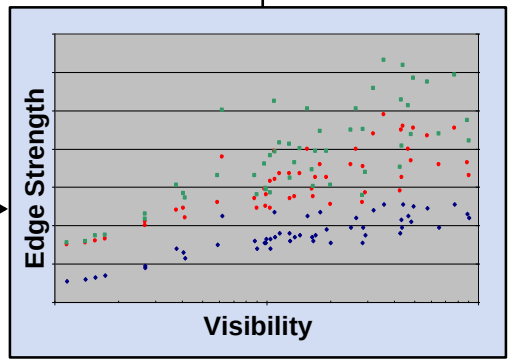


Image Registration



Clear day composite image & edges

Normalized Edge Extraction

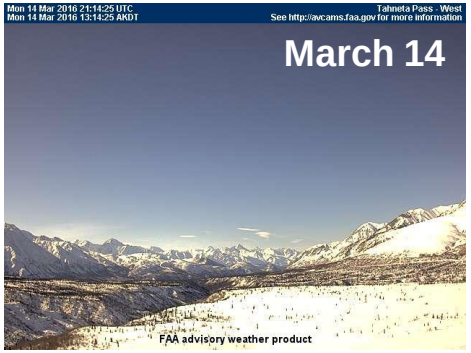


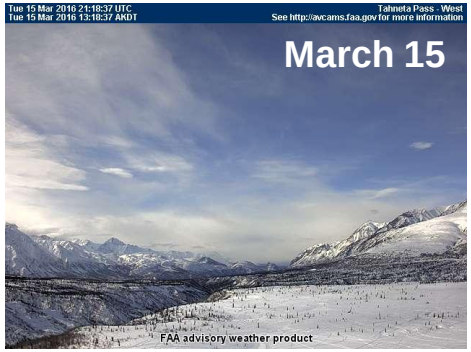
Visibility Estimator

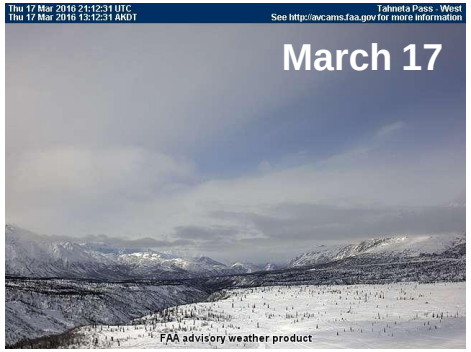
Visibility:
10+
miles

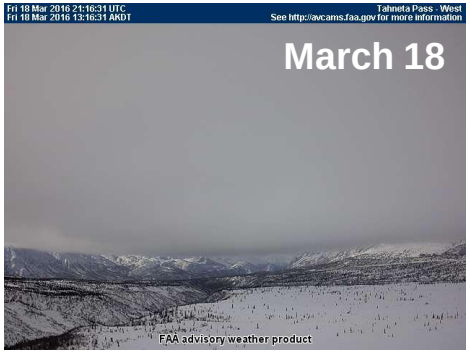
Example Visibility Estimates:

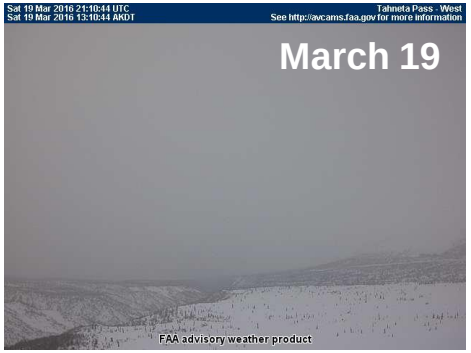
Tahneta Pass, March 14 to March 21, 2016

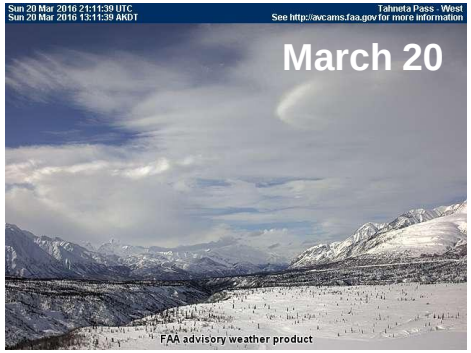


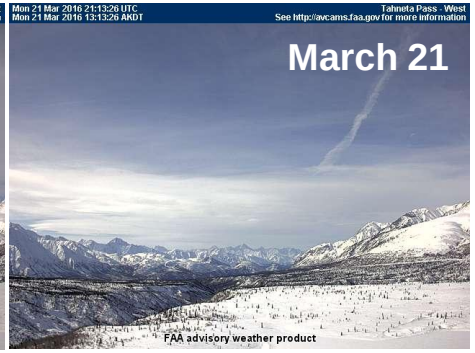




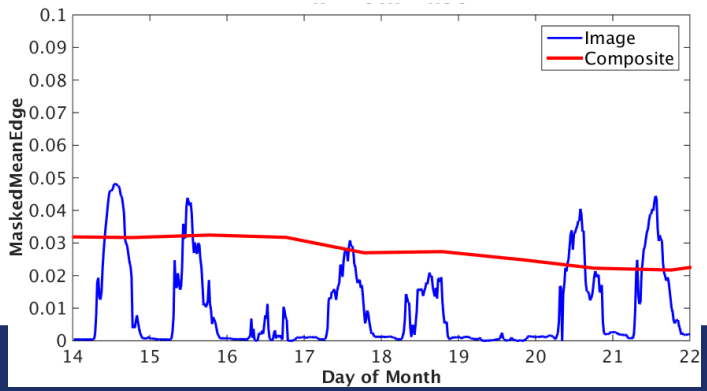


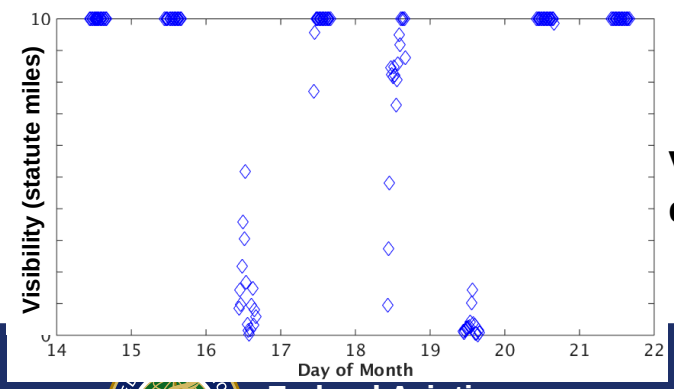






Edge strength





Visibility estimate

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Example Preliminary Comparison
Homer, AK Northeast

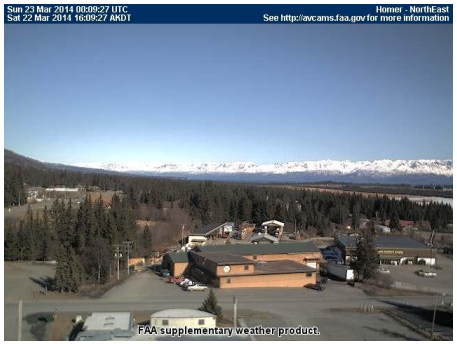
ASOS Visibility (miles)

Video Algorithm Visibility (miles)	<1	1-5	5-10	≥ 10
<1	12	16	2	9
1-5	17	36	57	236
5-10	4	55	207	1507
≥ 10	3	79	222	9629

Homer NE Camera, Jan 2014 – Dec 2015

Max Visibility = 12.0 SM

Each cell = number of observations



Overall match rate = 82%
<10 mile match rate = 36%

Currently pursuing modifications to improve performance

Image Analysis – total vs. crop

Camera: 10189 ASOS: PAMC SolAngle: 85

Camera overestimates visibility using ratio of edge strength to composite

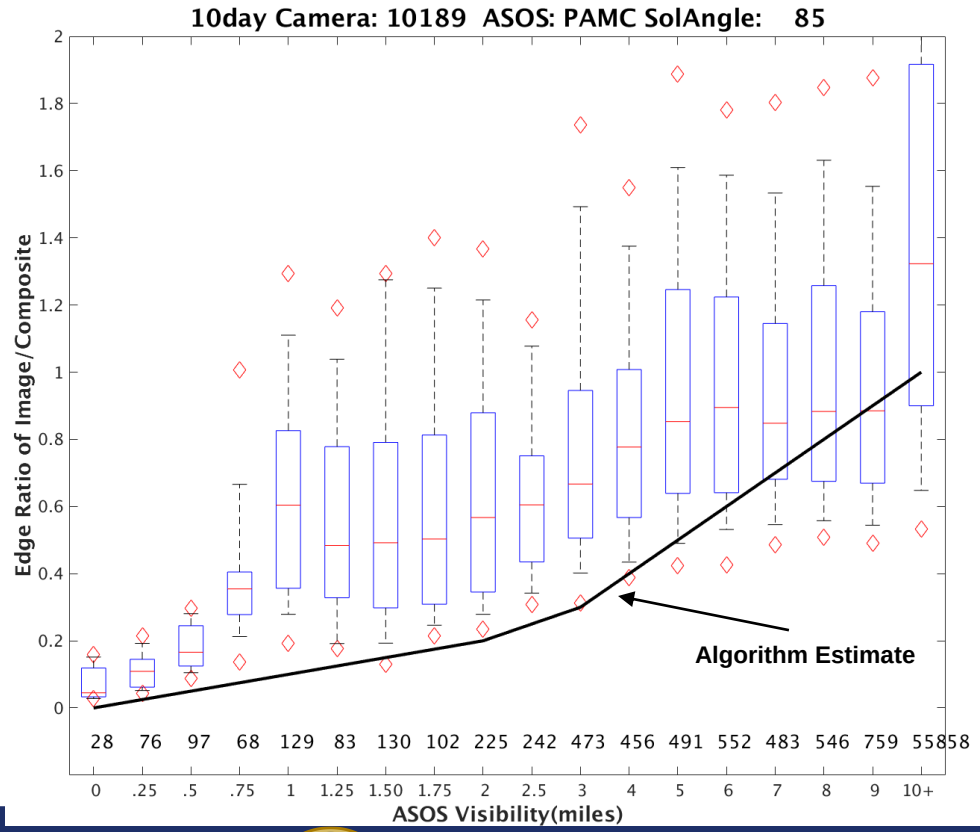
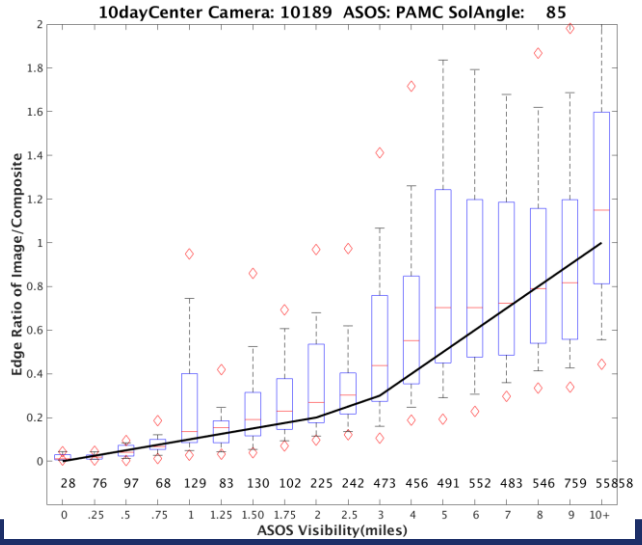
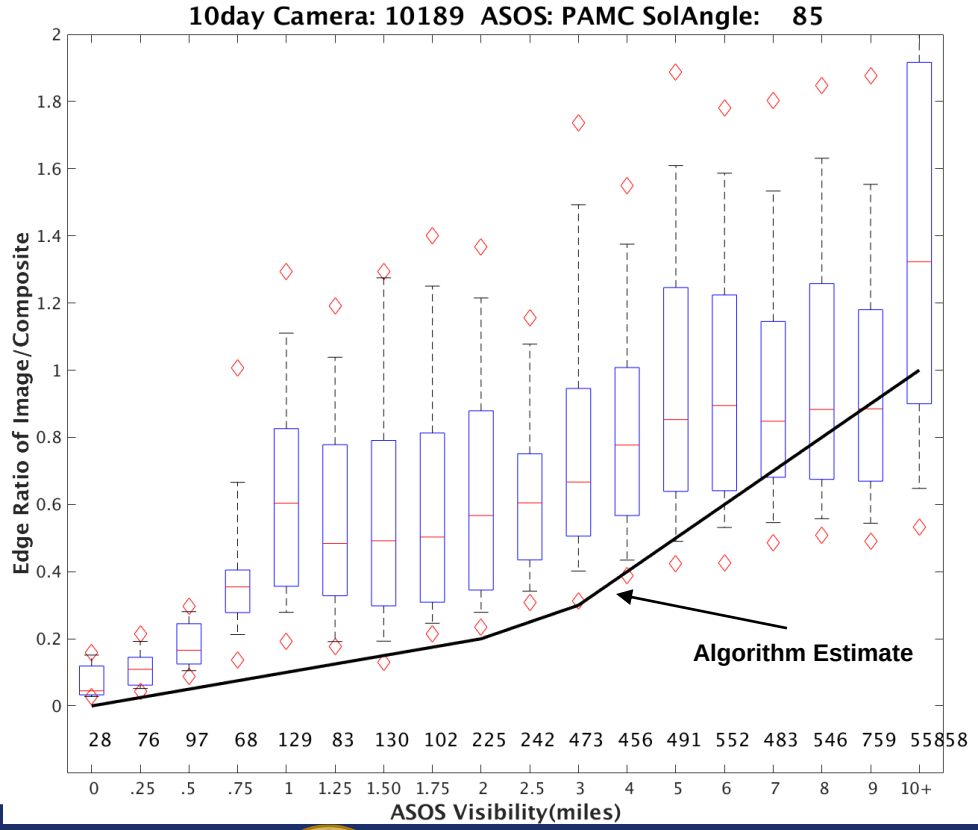


Image Analysis – total vs. crop

Camera: 10189 ASOS: PAMC SolAngle: 85

Using a different portion of the same image improves the results





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AvCam Visibility Estimate Development

- **Preliminary edge detection results look promising**
- **Exploring techniques to improve performance**
  - Machine learning
  - Assess individual pixels or cropped image vs. entire image
- **Challenges**
  - Alaska specific: limited lighting in winter, significant snow cover, extended periods of low vis, maximum visible range varies (from 60+miles to <1 mile)
  - When algorithm does not agree with METAR, manual review of image often favors algorithm result

AvCam Visibility Future Research

- **WTIC & AWRP collaborate to develop hybrid human-machine capability**
  - Use input of the ASOS and MITLL edge detection and see how they all score as crowd evaluators and how quickly it enables convergence to an accurate solution.
  - Use crowd solution to feed into machine learning of MIT/LL algorithm
- **Collaboration with NCAR for validation, QC, and initial integration of MIT/LL visibility estimates into prototype CVA-AK.**
- **Once mature, potential operational implementation**
  - AvCams*Plus* program
  - Data input for RTMA / weather models