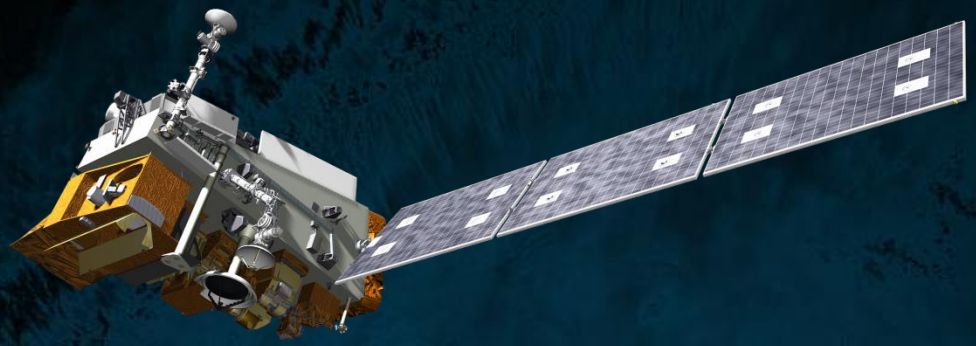


Joint Polar Satellite System

NOAA's Next-Generation Polar Orbiting Environmental Satellite System

Aviation Initiative

Jeff Weinrich, Science and Technology Corporation (STC)

GLOBAL DATA.
LOCAL WEATHER.

Agenda

- Introduction to JPSS
- Proving Ground Initiatives
- Aviation Initiative
- Demonstration planning
- Conclusion/Summary

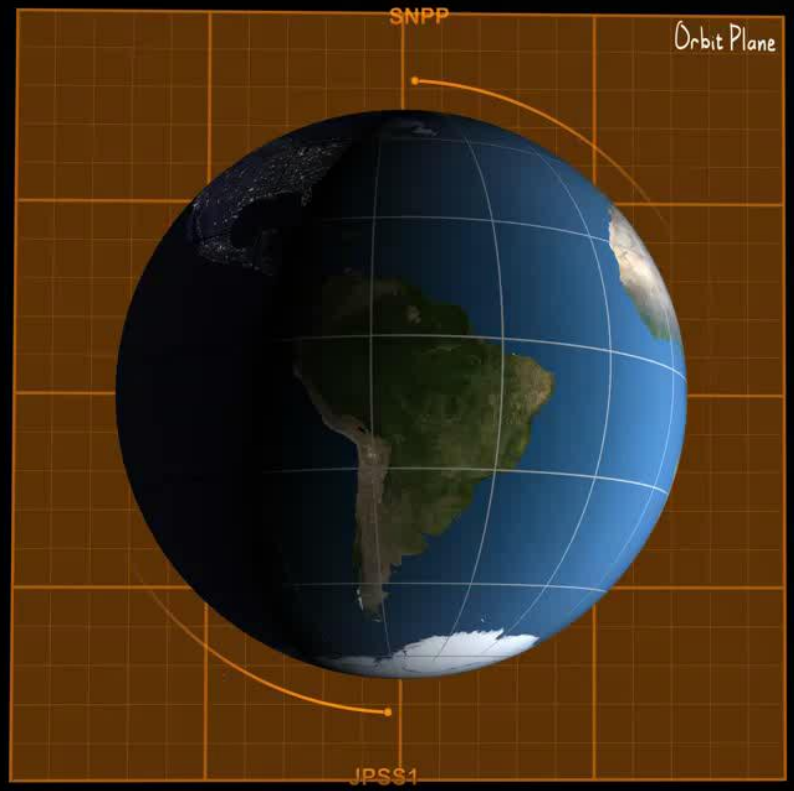
We Have Liftoff!

JPSS-1 (now NOAA-20), the first of NOAA's new Joint Polar Satellite System is now in orbit! Launched November 18, 2017.

Improving Forecast Accuracy & Timeliness

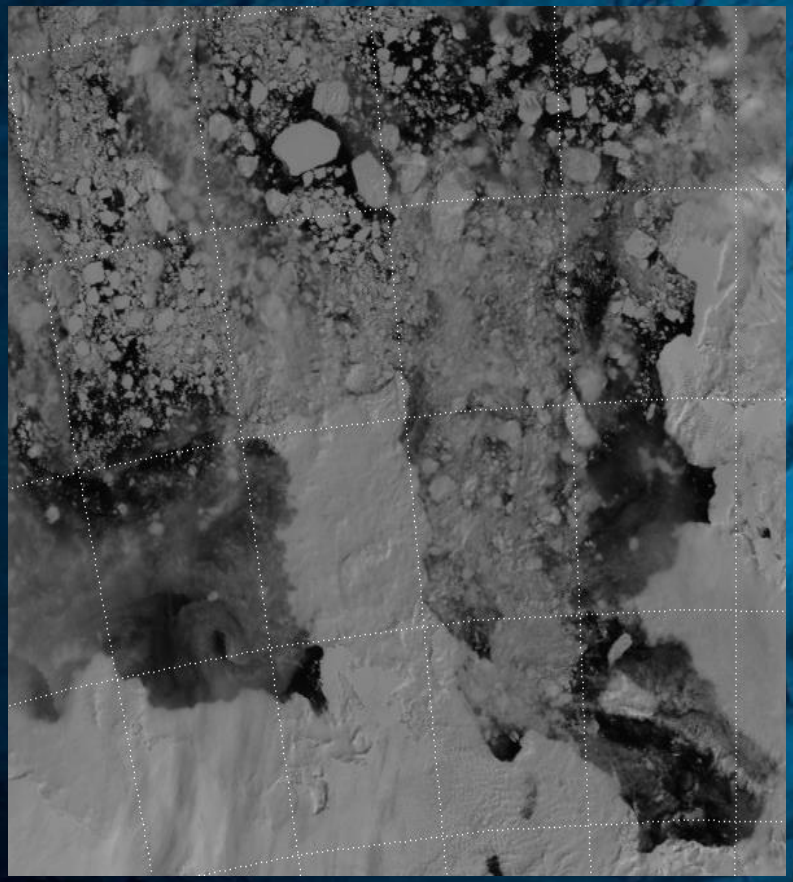
JPSS satellites:

- Circle the Earth from pole-to-pole and cross the equator 14 times daily in the afternoon orbit—providing full global coverage twice a day.
- Provide critical data to the numerical forecast models that produce 3- to 7-day mid-range forecasts.

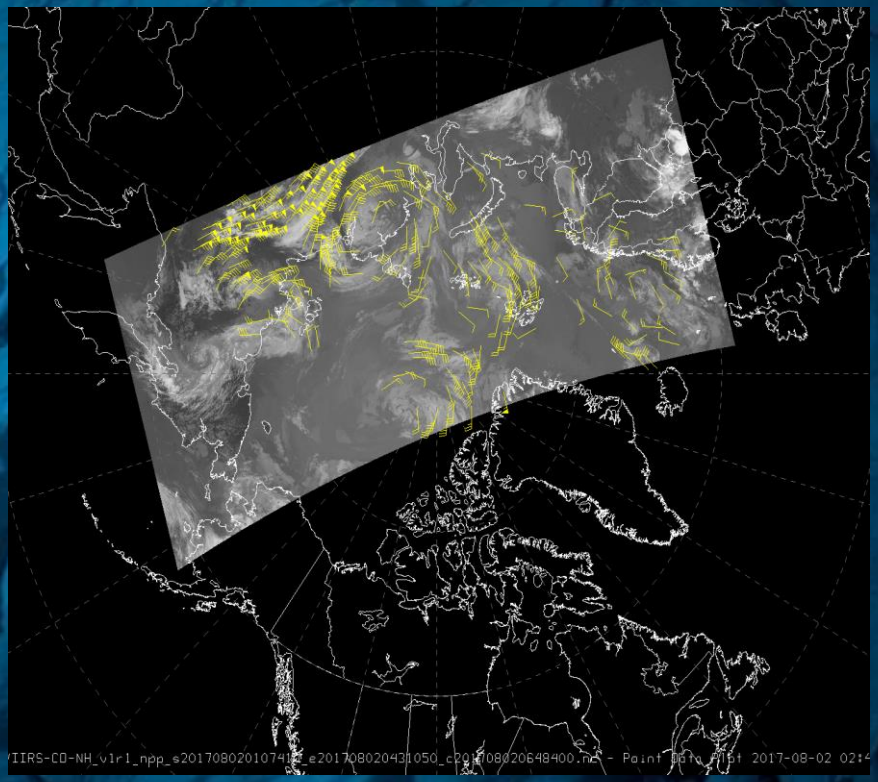


- Provide support for zero to 3-day operational forecasting in Polar Regions (where other observational data are sparse).

Excellent coverage in the polar regions



Ice Monitoring



Clouds and Winds over the North Polar region from space.

Twice the Downlinks, More Timely Data

NOAA-20 is flying in the same orbit as Suomi NPP, 50 minutes apart.

- **Two satellites in the same orbit = twice the data**
- **Two receiving stations (at both poles) = downlinks from NOAA-20 twice as often**

S-NPP

- **Downlinks only at Svalbard**
- **E2E latency requirement of 147 min**

JPSS-1

- **Downlinks at Svalbard and McMurdo**
- **E2E latency requirement of 96 min**

*E2E Latency includes from observation by the satellite, downlink to ground antennas, data processing, reformatting, and availability to the user

JPSS Proving Ground Initiatives

- What is an initiative? An interagency group of developers, service area providers, and stakeholders that frequently interact in a structured forum to address challenges in NOAA and partner service areas.
- Initiative activities
  - Products/capabilities are evaluated to ensure their optimal use in these focus areas.
  - Based on user feedback, changes to these capabilities are considered to increase their effectiveness
  - Actions to transition these capabilities to user operations are identified and implemented
- Why are initiatives successful?
  - Well defined objectives established and specific actions worked
  - Stakeholders are actively participating with engagement of the user advocate.
  - Products and capabilities are evaluated in operational environments
  - Monthly and bi-monthly meetings ensure proposed improvements can be worked on and then implemented quickly

Proving Ground Initiatives

- River Ice and Flooding
- Fire and Smoke (Aerosols)
- Sounding Applications
- NWP Impact Studies and Critical Weather
- OCONUS/AWIPS (Imagery/Nowcasting)
- Ocean and Coastal
- Hydrology
- Arctic (Crysophere)
- Land Data Assimilation
- Atmospheric Chemistry
- Aviation

Aviation Initiative Overview

- Focus on polar data needs for aviation users
- Concentrating on Alaska aviation users at first
- Subject areas include clouds, icing, turbulence, cold air aloft (CAA)
- New Volcanic Ash Initiative will work closely with Aviation Initiative due to similar objectives
- Began in June 2018

Aviation Initiative Goals

- Continue providing AK with JPSS/VIIRS cloud products
- Establish an Alaskan User for the cloud macrophysical (vertical structure) products included in the new Cloud Cover and Layers (CCL) formulation
- Build relationships for perhaps extending into other products where people expressed interest
- Investigating the value of the quantitative products
- Alaska region has expressed a renewed interest in JPSS / VIIRS cloud products
- Continue demonstrations based on interest and type of season
- Expand to international users
- Determine how polar data improves diagnosis and forecast of aviation hazards.

- Partners:

  JPSS Program Science, CIMSS, CIRA, GINA, Arctic Testbed

Initiative Participants

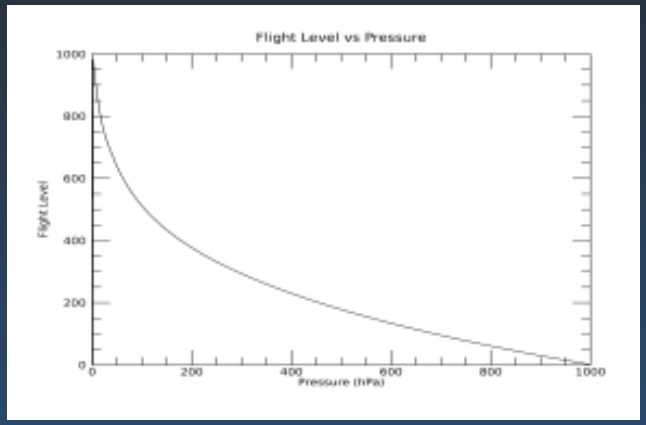
Alaska Aviation Weather Unit (AAWU)	Environment Canada
NWS Center Weather Service Units	Federal Aviation Administration Flight Service
NWS Forecast Offices	Private Pilots
National Transportation Safety Board	You?

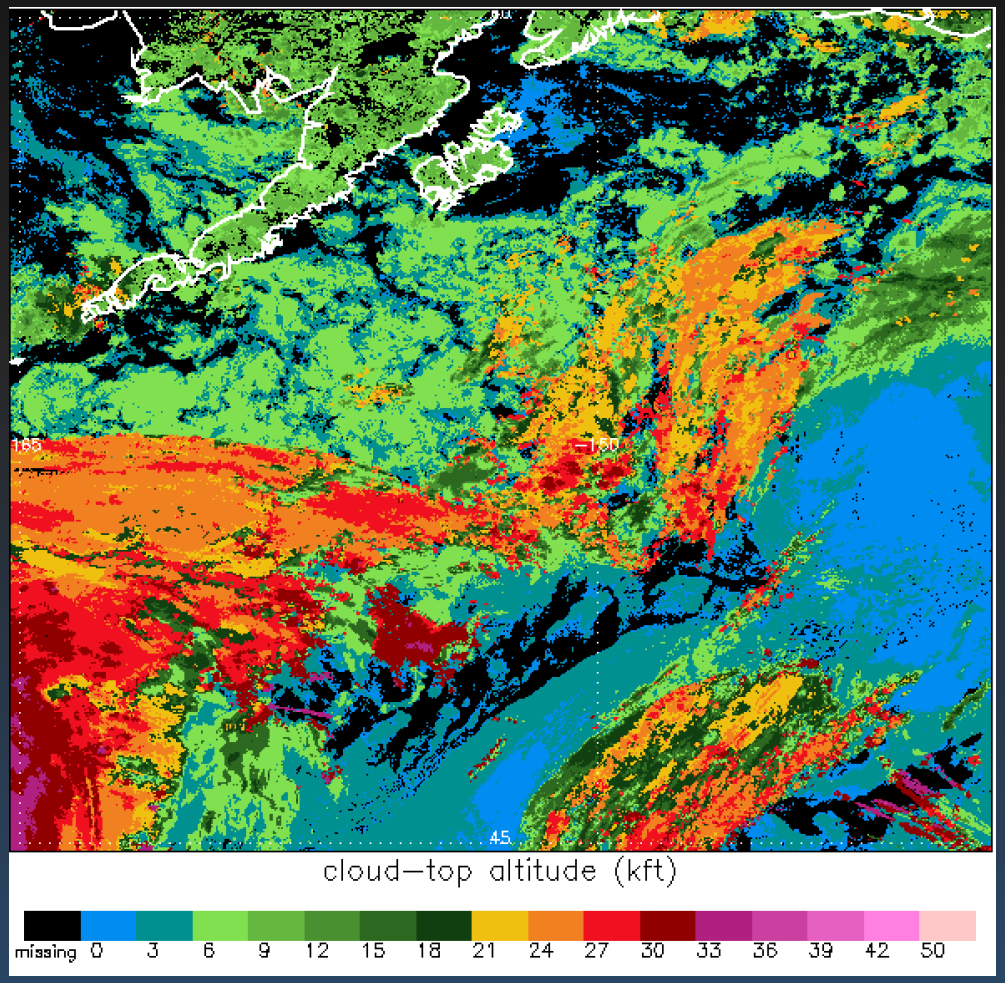
JPSS Data Products

- Users expressed an interest in the cloud macrophysical products:
  - Cloud top altitude
  - Cloud base altitude
  - Cloud geometrical thickness
  - Cloud cover at flight levels
- Would like to provide these other aviation centric products
  - Supercooled water probability at cloud top
  - Supercooled water probability on flight levels
- JPSS Cloud Product Winter Demonstration was from 3 Dec to 31 Dec
  - Training has been given to the users directly from the experts that developed the products
  - More and more users asking to join and participate

Cloud Top Altitude

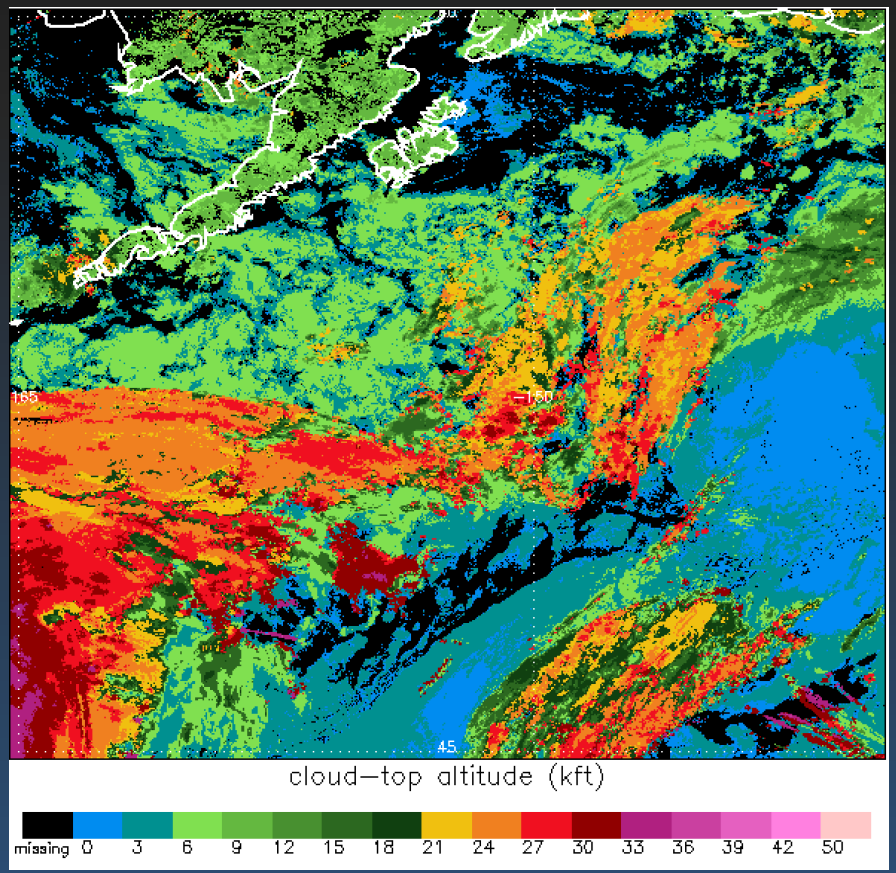
- Based on Cloud-top Pressure.
- Cloud-top Pressure converted to Cloud-top Altitude using standard relationship (below)

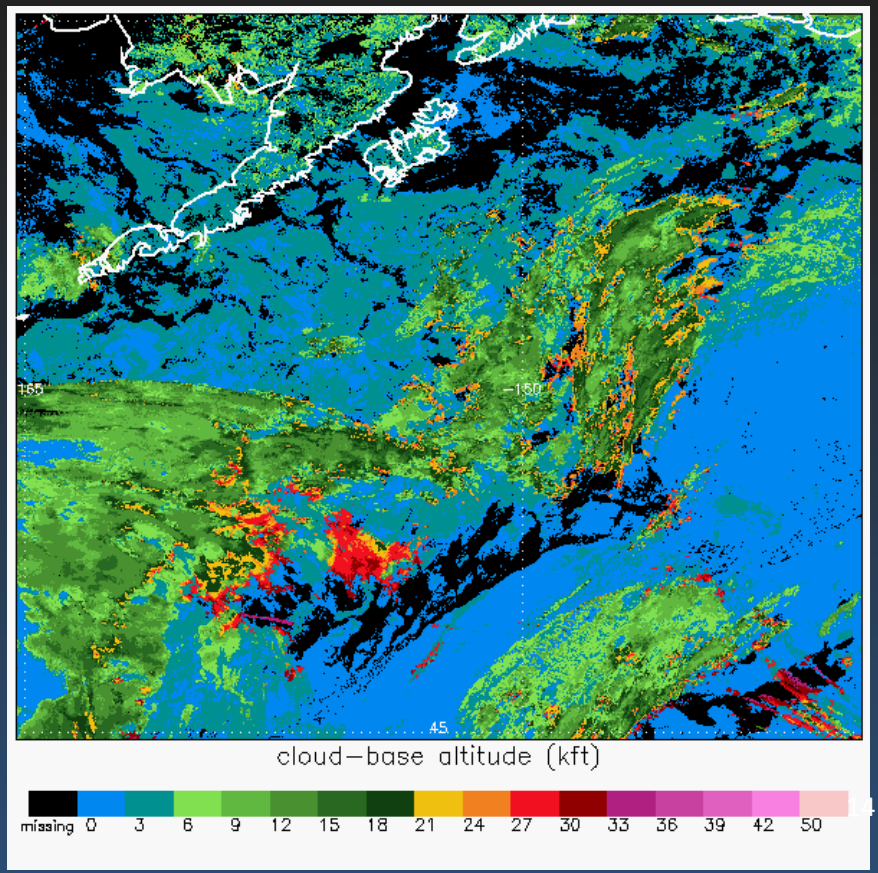




Cloud Base Altitude

- Based on Cloud-top Pressure + Geometrical Thickness.
- Altitude derived from Pressure using same relationship.
- Altitude of the highest cloud in the column

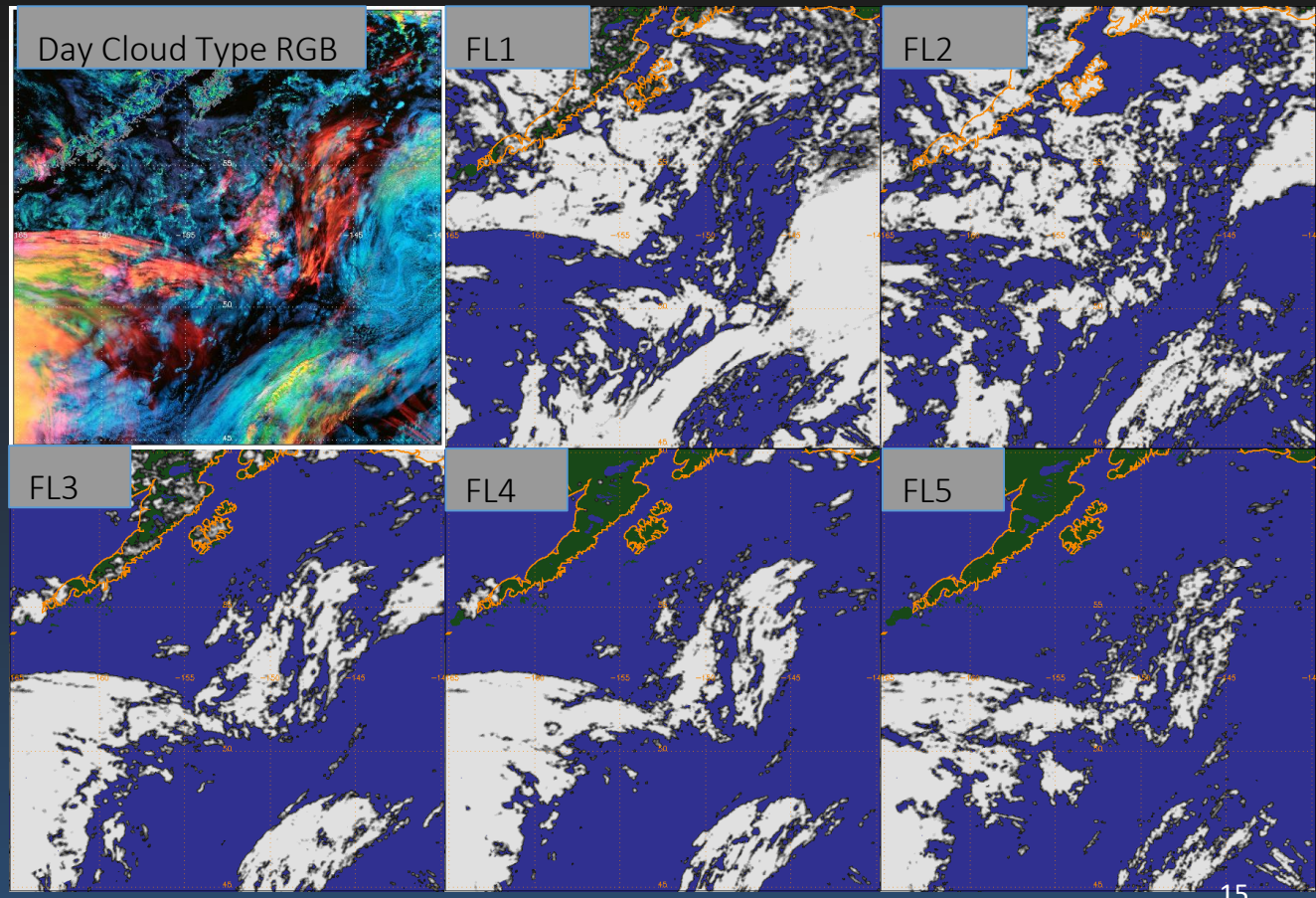




Cloud Cover Layers (CCL)

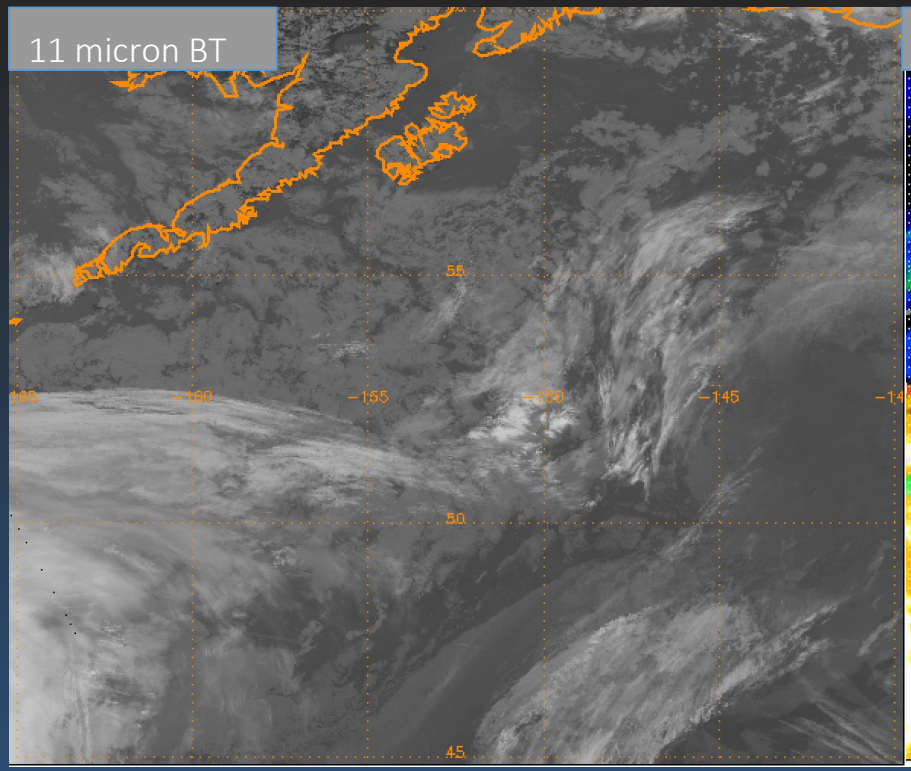
Layer #	Cld Alt (kft)
1	0-5
2	5-10
3	10-18
4	18-24
5	24-100

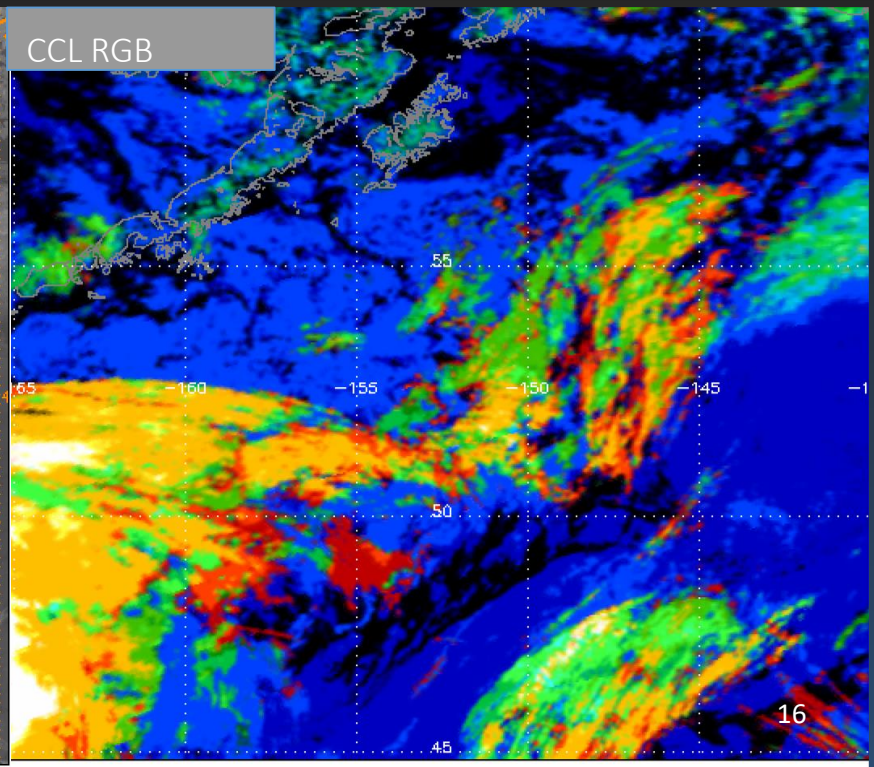
- Gives the cloud fraction in 5 layers defined by flight levels.
- Uses cloud base to extend cloud into lower layers.



CCL RGB

- Converts the 5 layers of CCL into a single image.
- Red = highest 2 layers, Green = middle 3 layers and Blue = lowest 2 layers.
- Working on having 5 layer values available by clicking



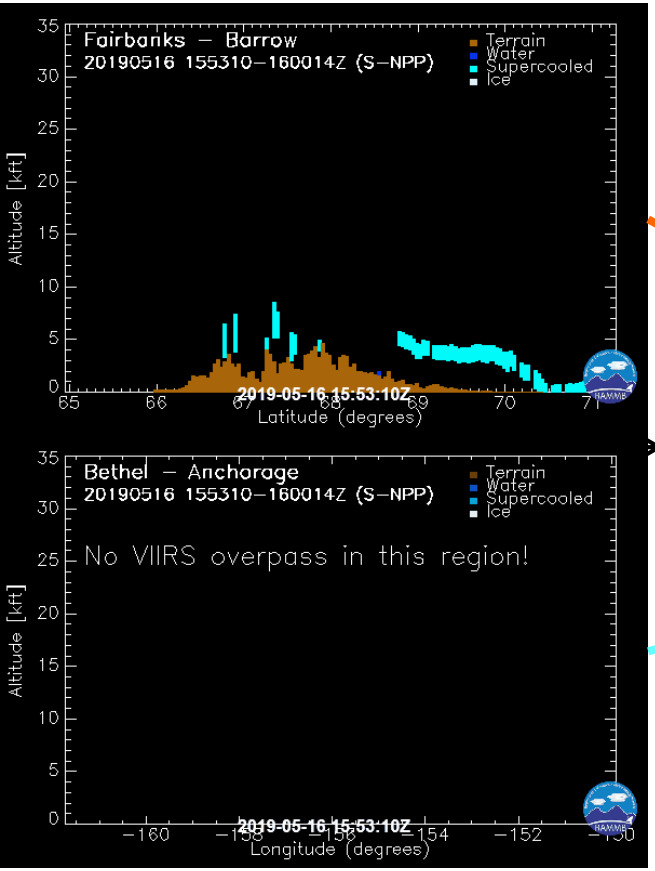


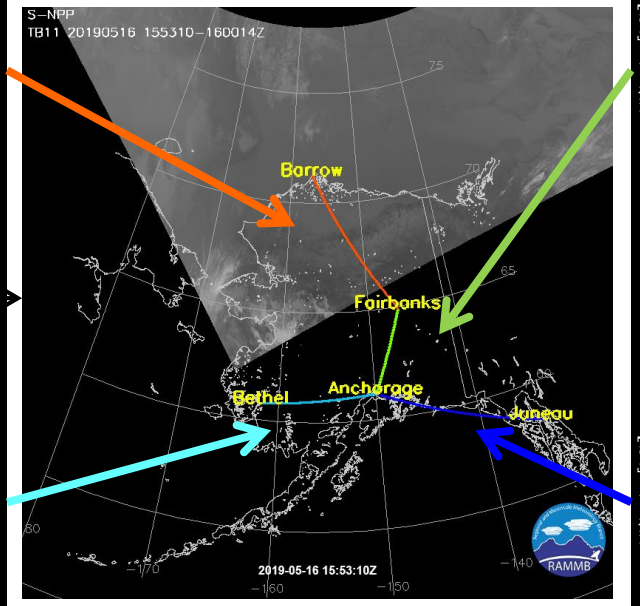
Cloud Product Cross-Sections Along Flight Paths

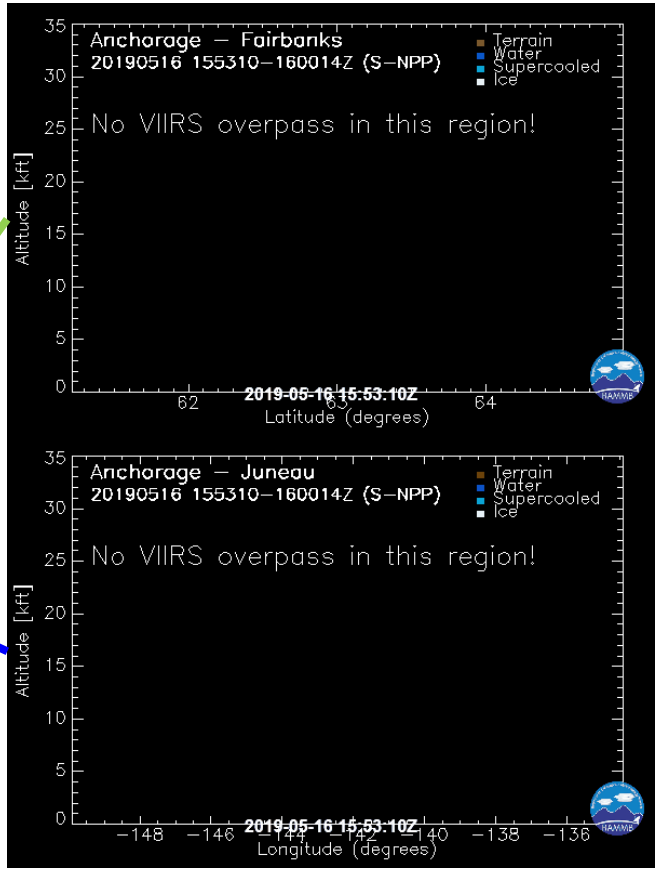
Thanks to Adam White and Tom George for assisting
Thanks to Andy Heidinger and the NOAA STAR Cloud Team for developing the cross sections.

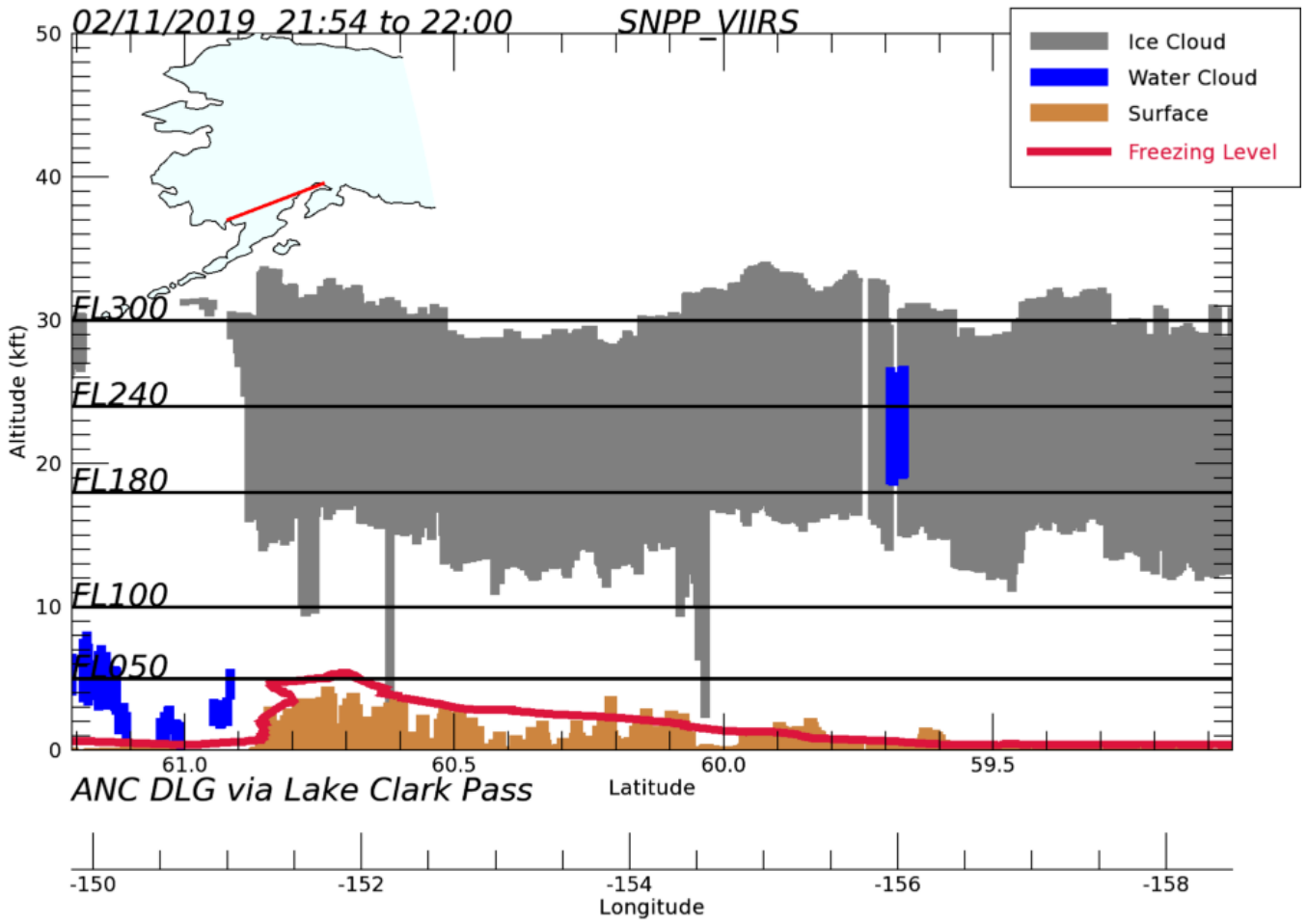
VIIRS imagery and cloud products over Alaska

http://rammb.cira.colostate.edu/ramsdis/online/npp_viirs_arctic.asp

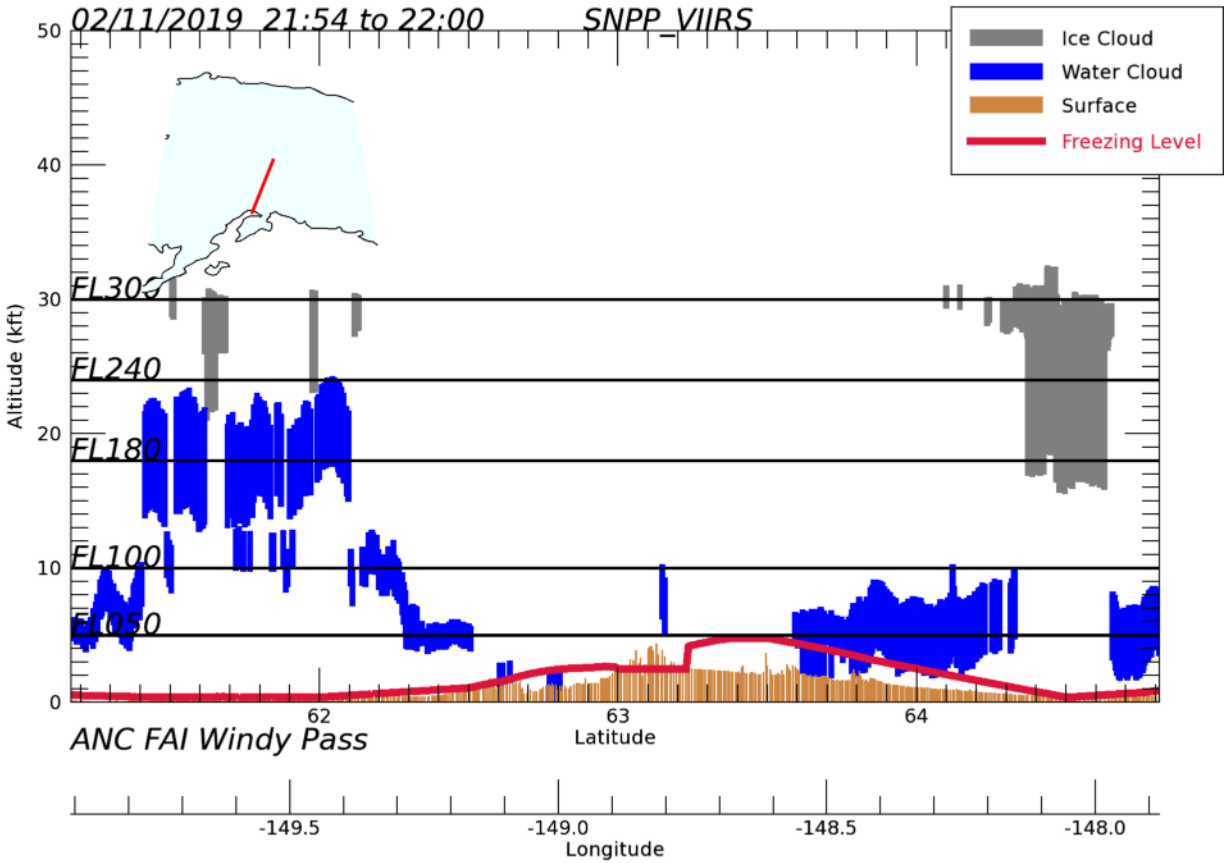








Andy Heidinger and STAR Cloud Team



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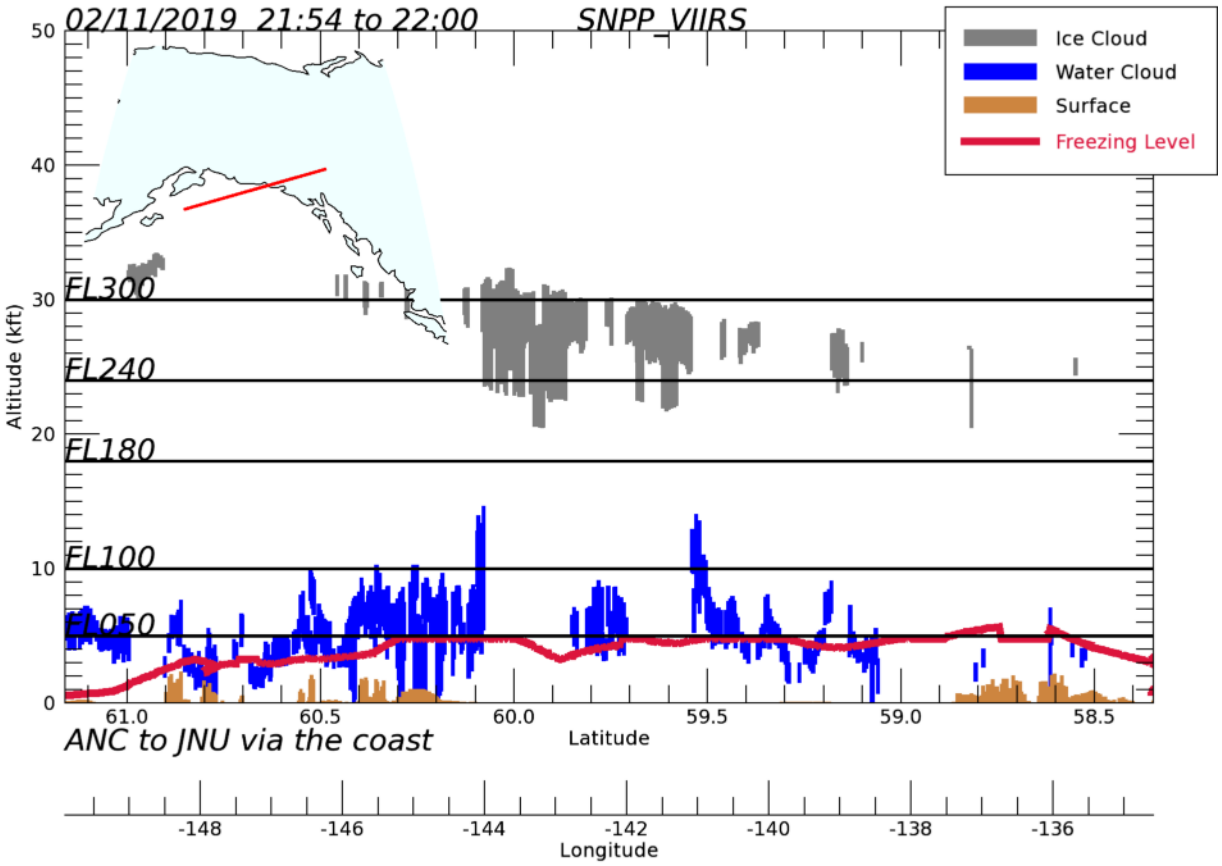
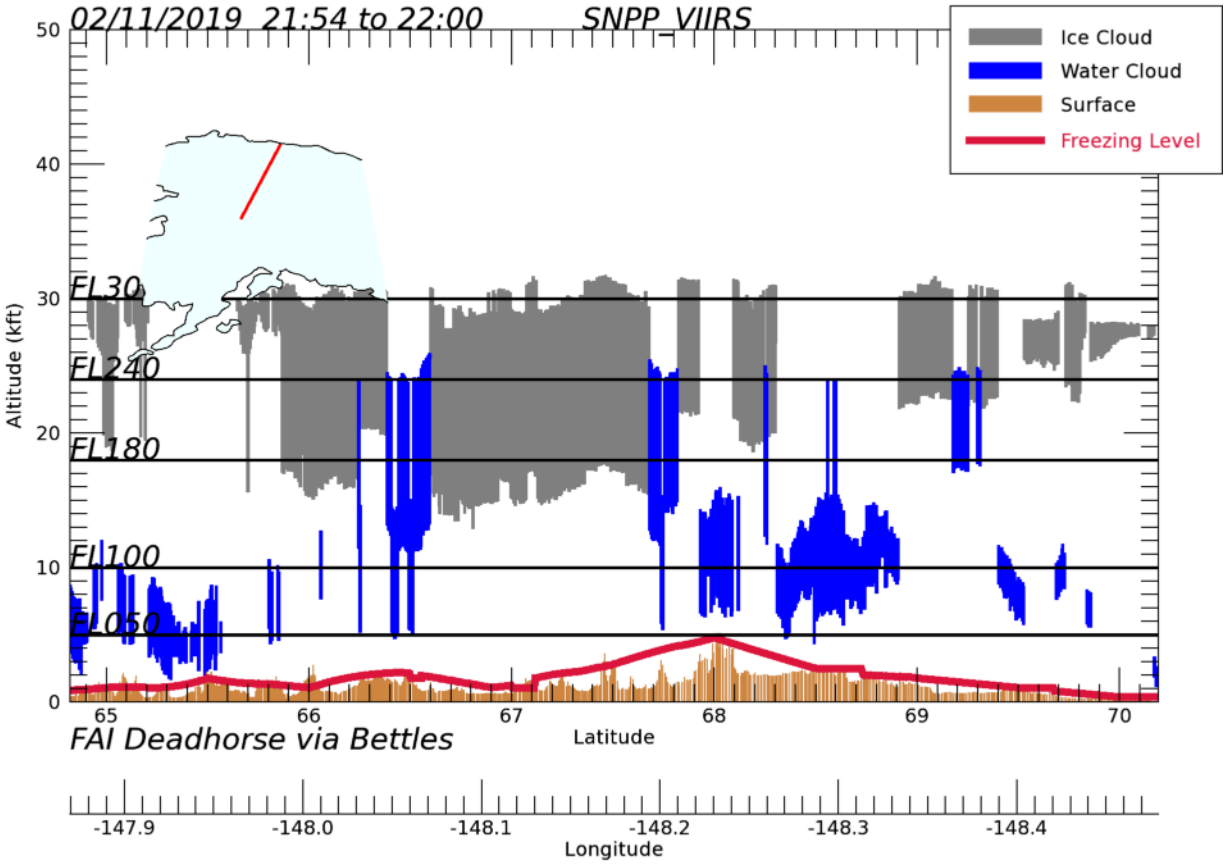
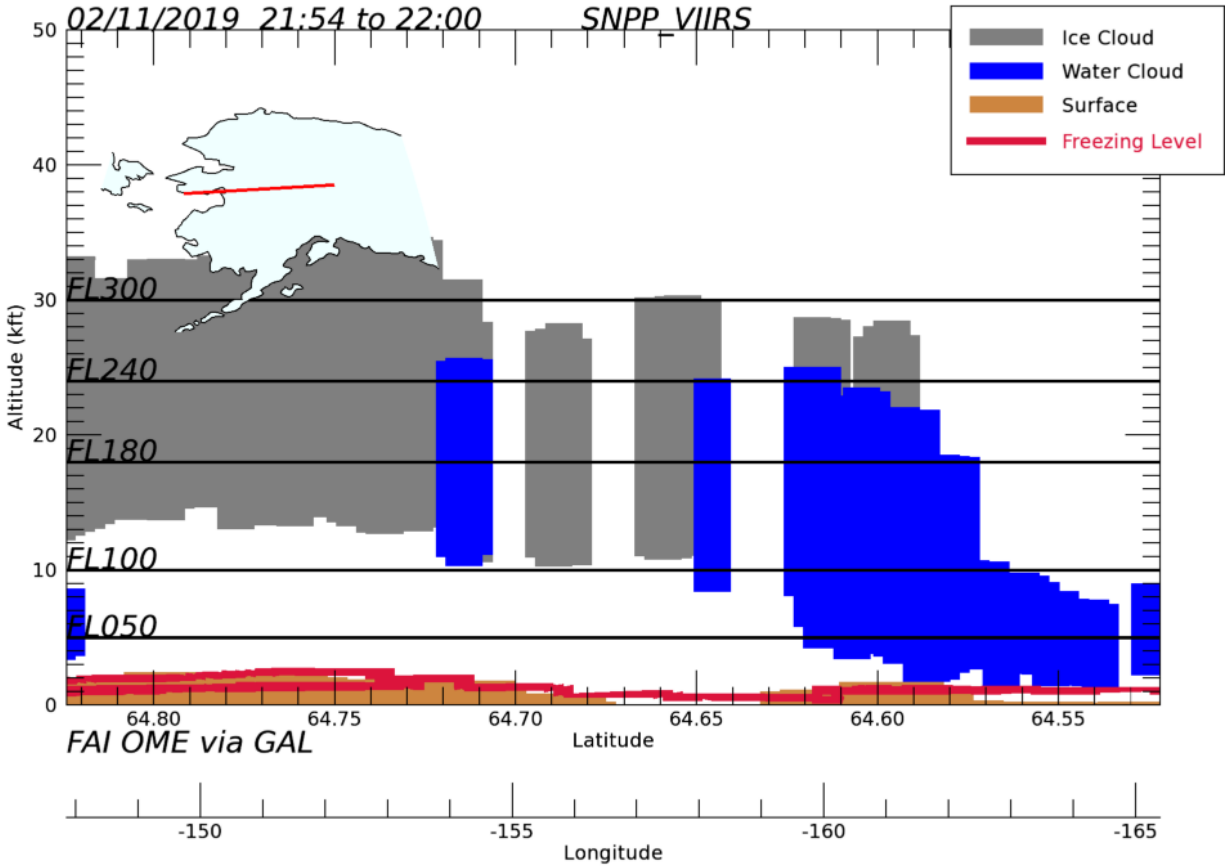


Andy Heidinger and STAR Cloud Team



Andy Heidinger and STAR Cloud Team



Andy Heidinger and STAR Cloud Team

What we need from you?

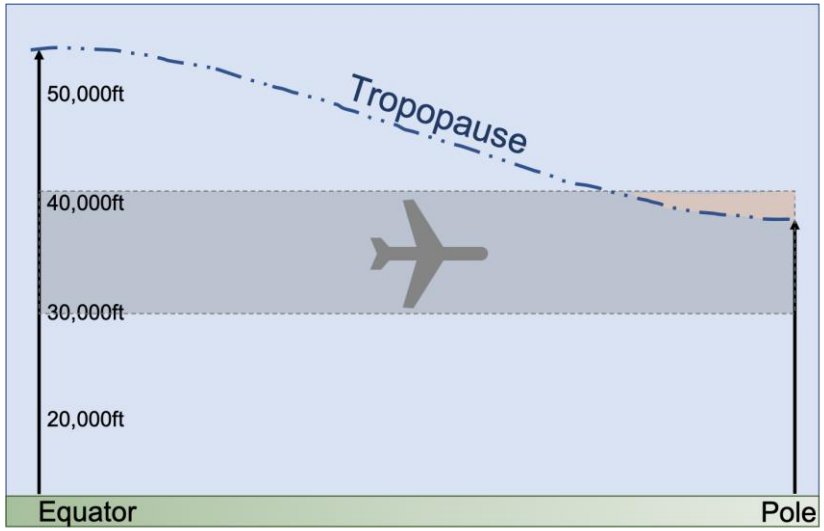
- Pilot Reports!
- To validate the cross section we need Pilot Reports for both Clear conditions and cloud conditions
  - We need to know how accurate these new products are
- If you want to be involved please contact me!

jeffrey.weinrich@noaa.gov

Cold Air Aloft

What is Cold Air Aloft?

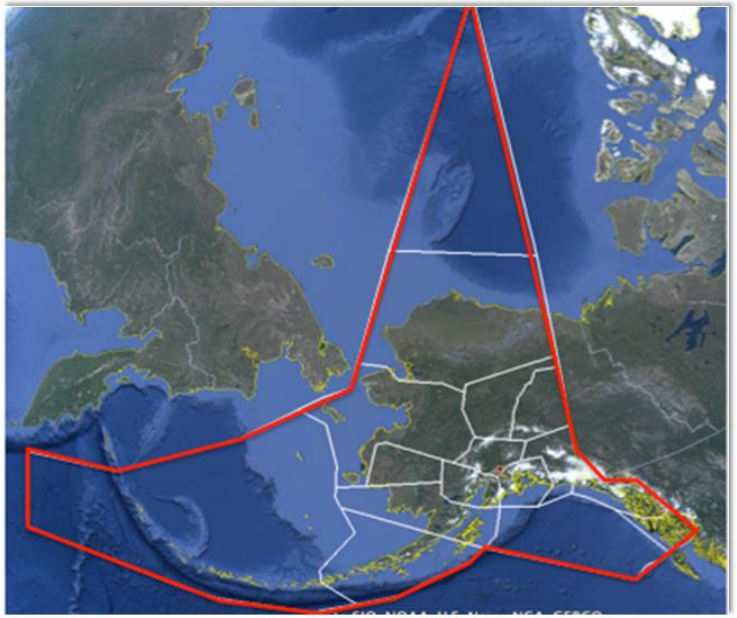
- Most commercial aircraft fly between 30,000 ft-40,000 ft
- In the tropics, the tropopause height is above 47,000 ft but in high latitudes it can dip below 40,000 ft
- Tropopause temperatures are <-65˚C, which can cause water within the jet fuel to freeze and common fuels begins to form wax crystals at -40˚C.
- Can increase fuel usage, at worst restrict fuel to the engine.
- Forecasting depressed tropopause height (Cold Air Aloft) can alert pilots and air traffic controllers in these regions.



Gail Weaver (NWS), Emily Berndt (NASA/SPoRT), Kris White (NWS, and NASA/SPoRT), Jack Dostalek (CIRA), Brad Zavodskey (NASA/SPoRT) and Nadia Smith (STC)

Issuing Hazard Warnings

- The **Anchorage Center Weather Service Unit (CWSU)** provides aviation hazard forecasts from the North Pole to the Russia, Japan, Canada and Oakland, California.
- CWSUs brief Air Traffic Controllers on the aviation weather conditions enroute.



Meteorological Impact Statement

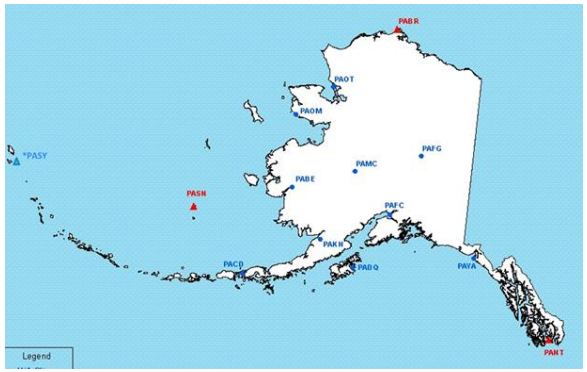
FAAK20 KZAN 082312
ZAN MIS 01 VALID 082312-090600
...FOR ATC PLANNING PURPOSES ONLY...
FROM 575NNW BRW-510NNE BRW-175NE SCC-BRW-200W BRW-572N BRW
COLD AIR ALOFT
TEMPS -65C OR LESS FM FL310-FL340. MOV E 15 KT. INTSF.
GMW DEC 16

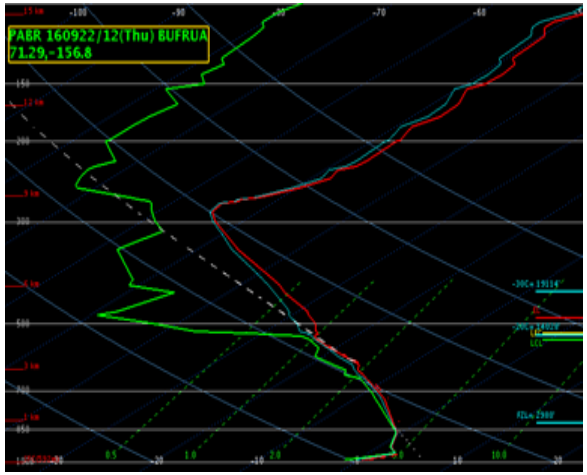
- The Anchorage CWSU issues a **Meteorological Impact Statement (MIS)** for Cold Air Aloft using -65˚C as the threshold.

Identification of Cold Air Aloft

- Identification of cold air aloft is determined in three dimensions from:
  1. NWP model forecasts
  2. Radiosondes which are launched from 14 locations across Alaska, 3x/day.

- Challenges:
  - Radiosondes can be hampered by bad weather, staffing, etc.
  - In-situ observations do not adequately sample the spatial extent and temporal resolution.
  - NWP models do not always agree on the presence and extent of CAA events





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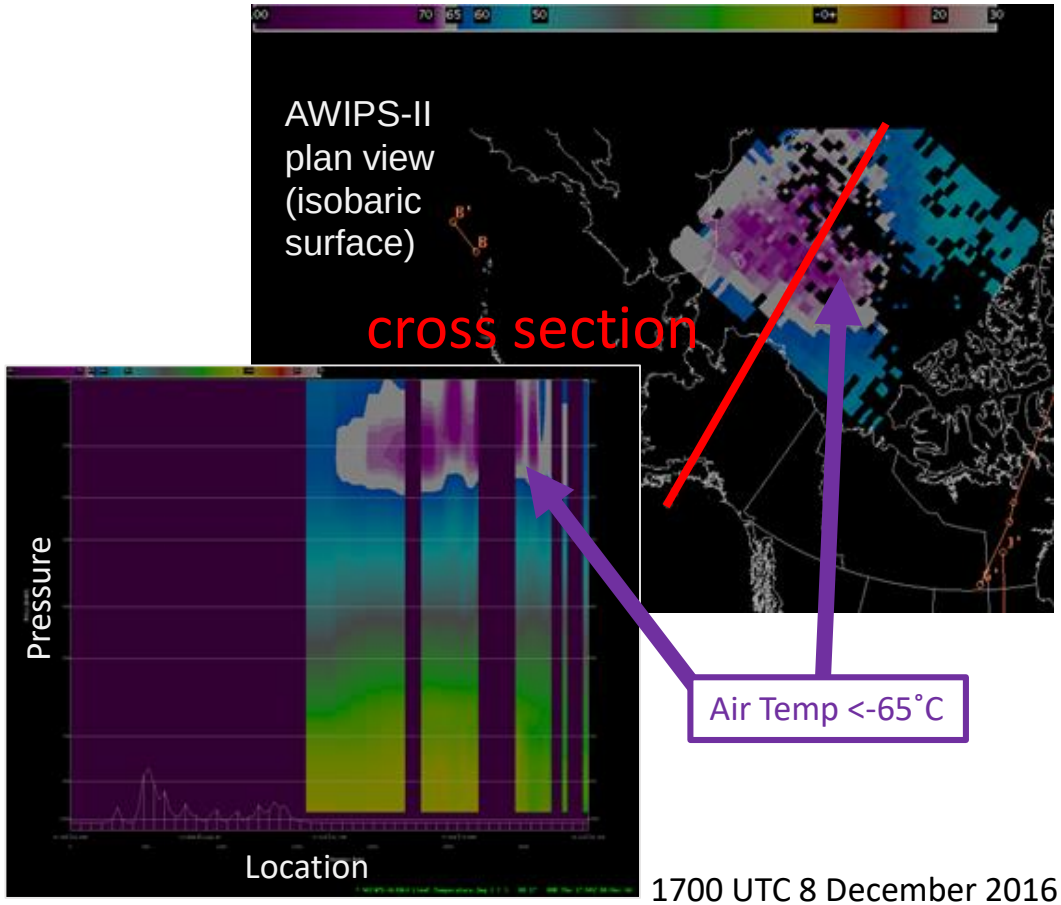
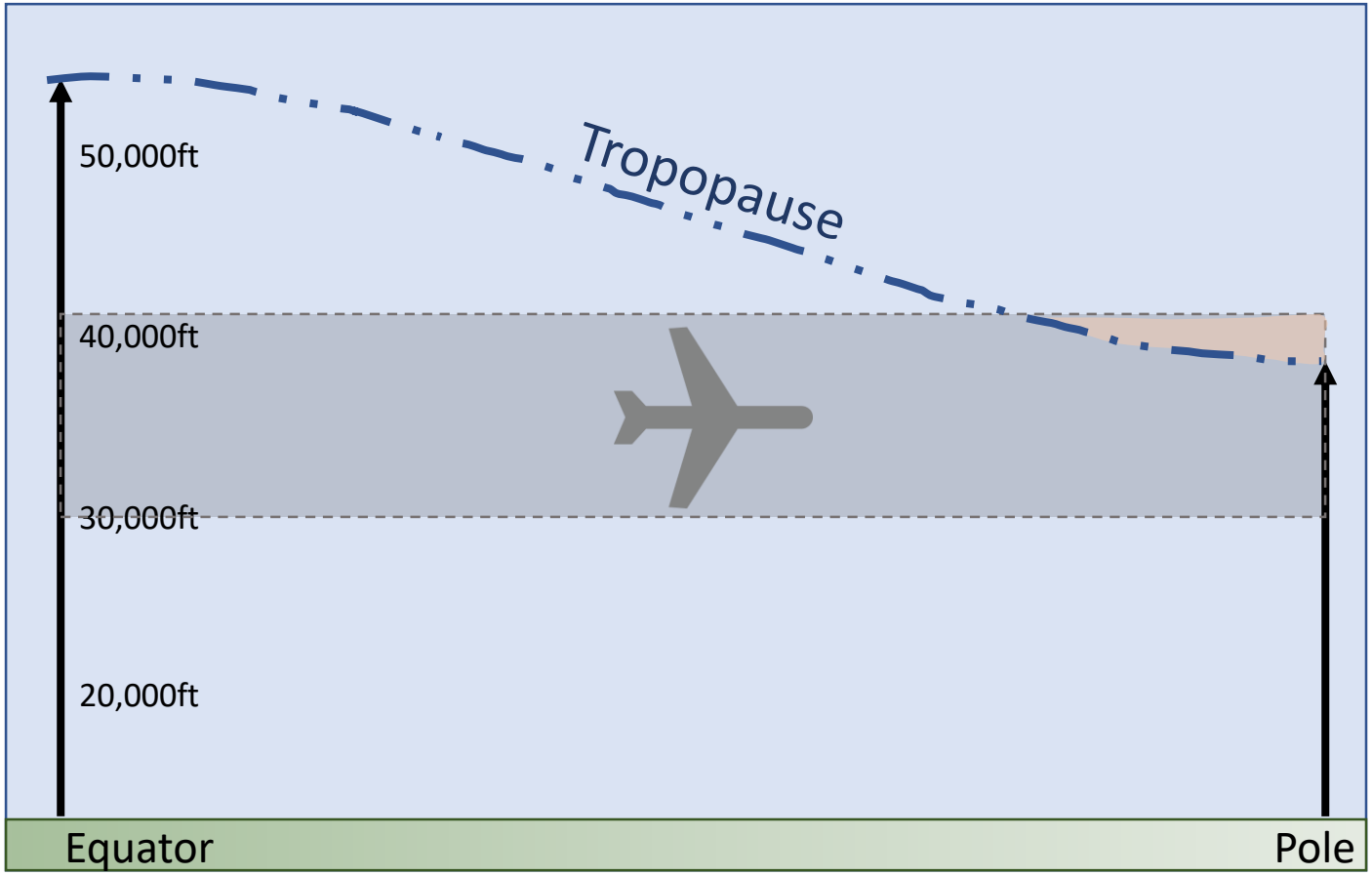
Enhancing prediction with Cold Air Aloft NUCAPS product

- The NOAA-Unique Combined Atmospheric Processing System (NUCAPS) from SNPP satellites provides soundings multiple times daily.
- Through PGRR program, developed Cold Air Aloft NUCAPS product in AWIPS-II within 40 to 60 minutes of the S-NPP satellite overpass.
- Complements in-situ obs. by representing entire event in 2200 km, 3D swaths to provide guidance to pilots/ATC.



1700 UTC 8 December 2016

Gail Weaver (NWS), Emily Berndt (NASA/SPoRT), Kris White (NWS, and NASA/SPoRT), Jack Dostalek (CIRA), Brad Zavodskey (NASA/SPoRT) and Nadia Smith (STC)


50,000ft
Tropopause
40,000ft
30,000ft
20,000ft
Equator
Pole

Cold Air – Jet Fuel Mitigating factors

http://aviation.stackexchange.com/questions/2185/how-do-aircraft-keep-the-temperature-of-the-fuel-tanks-above-freezing-point

- Initial fuel temperature – Warmer fuel is slower to freeze.
- Outside air temperature – Colder air freezes fuel faster.
- Aircraft Speed – Faster speeds generates more friction and more heat.
- Quantity of fuel – The greater amount of fuel in the tank, the slower it freezes.
- Aircraft design – constant pumping of fuel to mix it, hydraulic lines run close to fuel, etc.

Cold Air – Jet Fuel

Pilots'/Airlines' actions to mitigate in flight

- Use a fuel with a lower freezing point
- Fly at a lower altitude where it is not as cold
- Choose a route with warmer temperatures
- Increase the speed of the airplane
- Carry extra fuel
- Transfer fuel in a way to keep fuel warmer. (i.e. transferring fuel from warm large fuselage tanks to the wing tanks which are more exposed to cold air.)

Data Access and Resources

- Stored Mission Data (SMD) access
  - Product Distribution and Access (PDA): Designed for near real-time users. Access is managed/controlled by NESDIS/Office of Satellite Products and Operations;
  - Comprehensive Large Array-data Stewardship System (CLASS): Designed non real-time users. https://www.avl.class.noaa.gov
  - Global Telecommunications System (GTS): currently includes CrIS SDR and ATMS TDR
  - GEONEcast-Americas: Currently includes VIIRS DNB, I band Imagery, Blended TPW, Active Fires, MiRS, NUCAPS

- High Rate Data (HRD) / Direct Broadcast access
  - Available to users with antennas. Software available: http://cimss.ssec.wisc.edu/cspp/

- Algorithm maturity information and documentation: https://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php

Path Forward

- Document any feedback on JPSS Cloud Products
- Modify algorithms based on feedback
- Determine potential for uses of other areas in JPSS Product Suite.
- Plan additional JPSS Cloud Product demonstrations to cover additional seasons

Summary

- JPSS Aviation Initiative builds on user interaction from the JPSS Arctic Summit
- The JPSS Cloud Products Demo builds on the successful JPSS Arctic Summit
- First phase of Cloud Products demo focused on cloud vertical structure for aviation users in Alaska
- JPSS Cloud products already in the hands of the users as part of the demo
- Aviation community could benefit, especially in the high latitudes, from JPSS products
- Want to get involved? Tell us what your needs are!

Jeffrey.Weinrich@noaa.gov

Thank you!
Acknowledge Carl Dierking, Carrie Haisley, Tom George, Andy Heidinger, Arron Layns, Becca Mazur, Andrew McClure, Jeff Osiensky, Bonnie Reed, Nadia Smith, Jorel Torres, Gail Weaver, Adam White, CIRA and all the users for their help!

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Backup Slides

JPSS PGRR Background
Definitions

- **Proving Ground**
  - Demonstration and utilization of data products by the end-user operational unit, such as a NWS Weather Forecast Office or Modeling Center.
  - Promote outreach and coordination of new products with the end users, incorporating their feedback for product improvements

- **Risk Reduction**
  - Development of new research and applications to maximize the benefits of JPSS satellite data
    - Example - use of Day Night Band for improved fog and low visibility products at night, benefiting transportation industry.
  - Encourages fusion of data/information from multiple satellite, models and in-situ data
  - Primary work is done at the algorithm and application developer's institution.
  - Address potential risk in algorithms and data products by testing alternative algorithms.

.

PGRR Proving Ground Initiatives Responding to User Feedback

- The River Ice and Flooding Initiative was the first attempt at this new partnership and it was established in response to Galena AK flooding in May 2013.
- The Initiative included River Ice and River Flooding Project teams, direct broadcast SMEs, and National Weather Service River Forecast Center forecasters.
- The success of River Ice and Flooding Initiative led to creation of other initiatives that guided the 2014 PGRR CFP.
- Initiatives have proven to be critical forums where JPSS personnel, product developers, and users interact. The effort is to evaluate current and future JPSS Capabilities in operational environments to determine which of these capabilities should be transitioned to operations.

PGRR Initiatives List

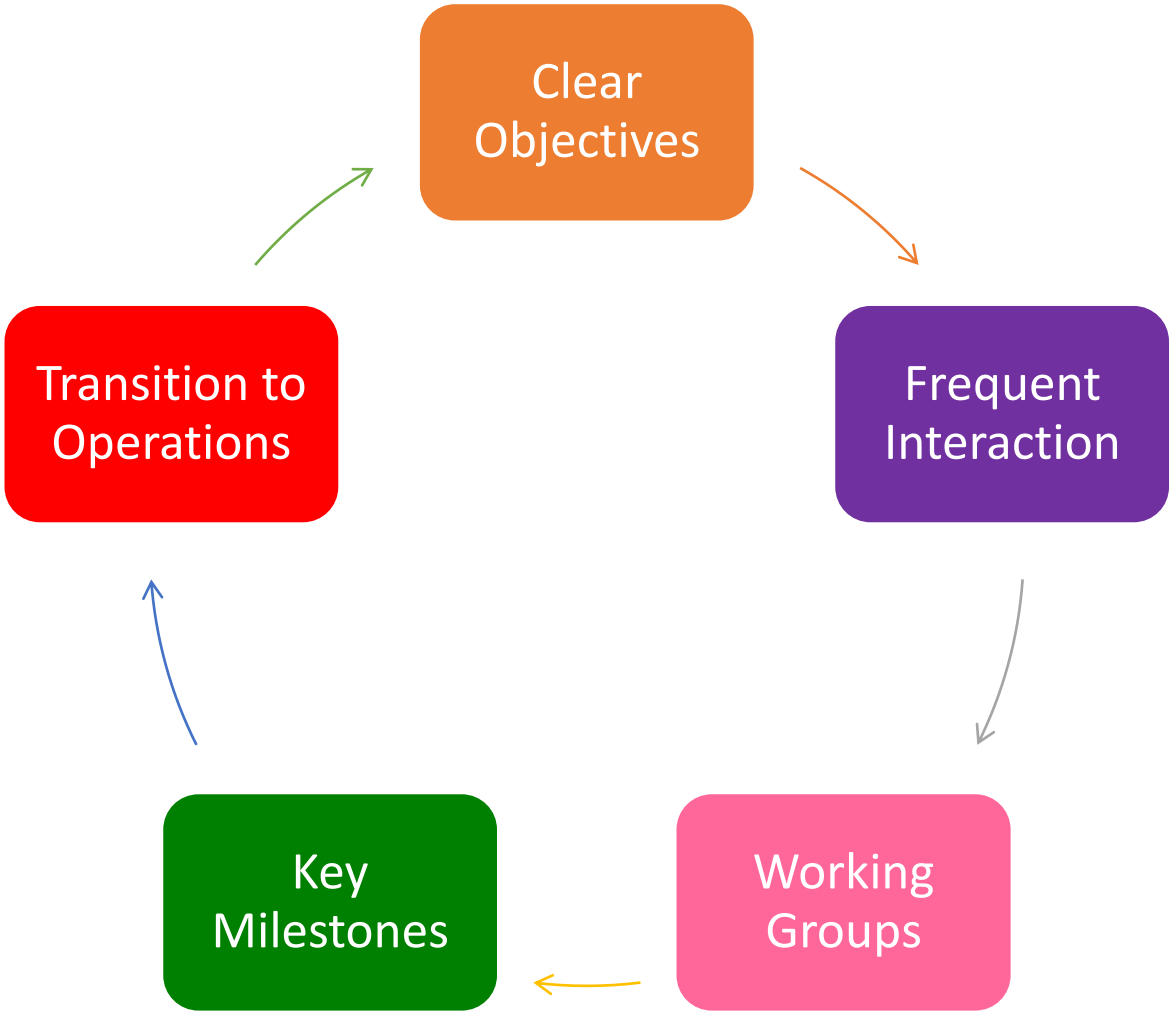
Blue – Most Recent from 2017 PGRR CFP

PGRR Initiatives

Initiative	Start Date
River Ice and Flooding	November 2013
Fire and Smoke	May 2014
Sounding Applications NOAA Unique CrIS/ATMS Processing System (NUCAPS)	July 2014
Hydrology	July 2015
Ocean and Coastal	March 2016
Severe Weather/NWP/Data Assimilation	March 2016
Arctic Initiative	June 2016
Hurricanes and Tropical Storms Initiative	June 2018
Aviation Initiative	June 2018
Training Initiative	June 2018
Volcano Initiative	June 2018

PGRR Initiatives Partners

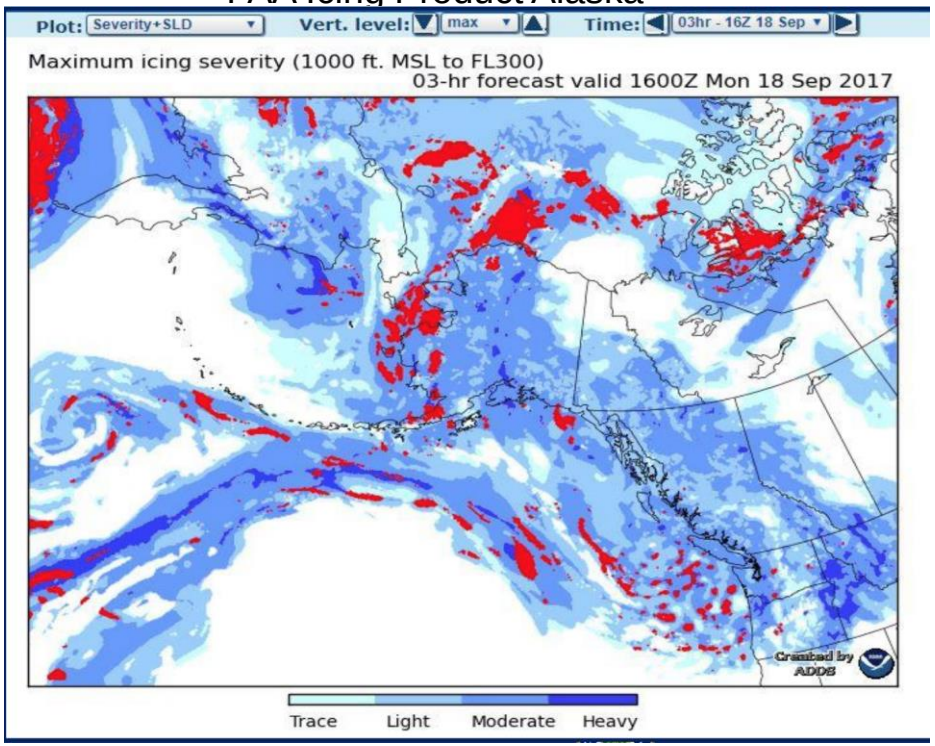
PGRR Proving Ground Initiatives Best Practices



Role of JPSS Cloud Products in Aviation

- AAWU is evaluating the FAA IPA.
- In CONUS, NCAR's CIP is a dominant source of Icing Information to the NOAA Aviation community.
- Is it relevant to the AAWU?
- CIP uses an NCAR cloud-top temperature but no other satellite products. (Not NOAA or NASA LaRC)
- Should our goal be to integrate with the IPA and the CIP?
- Should JPSS try to present its satellite products in a similar format?

FAA Icing Product Alaska



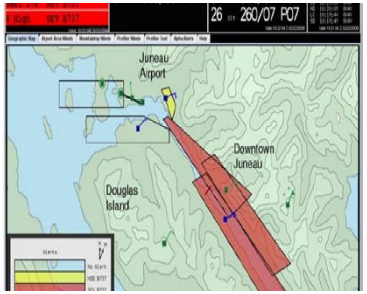
This is a product that is straightforward to make from JPSS suite. Is there value in a JPSS SLD product / image?

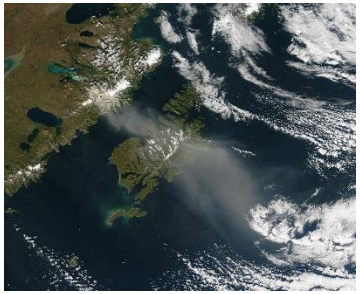
NWS Aviation Initiative Users

Alaska Aviation Weather Unit (AAWU)

National Weather Service Forecast Offices

National Weather Service Center Weather Service Units



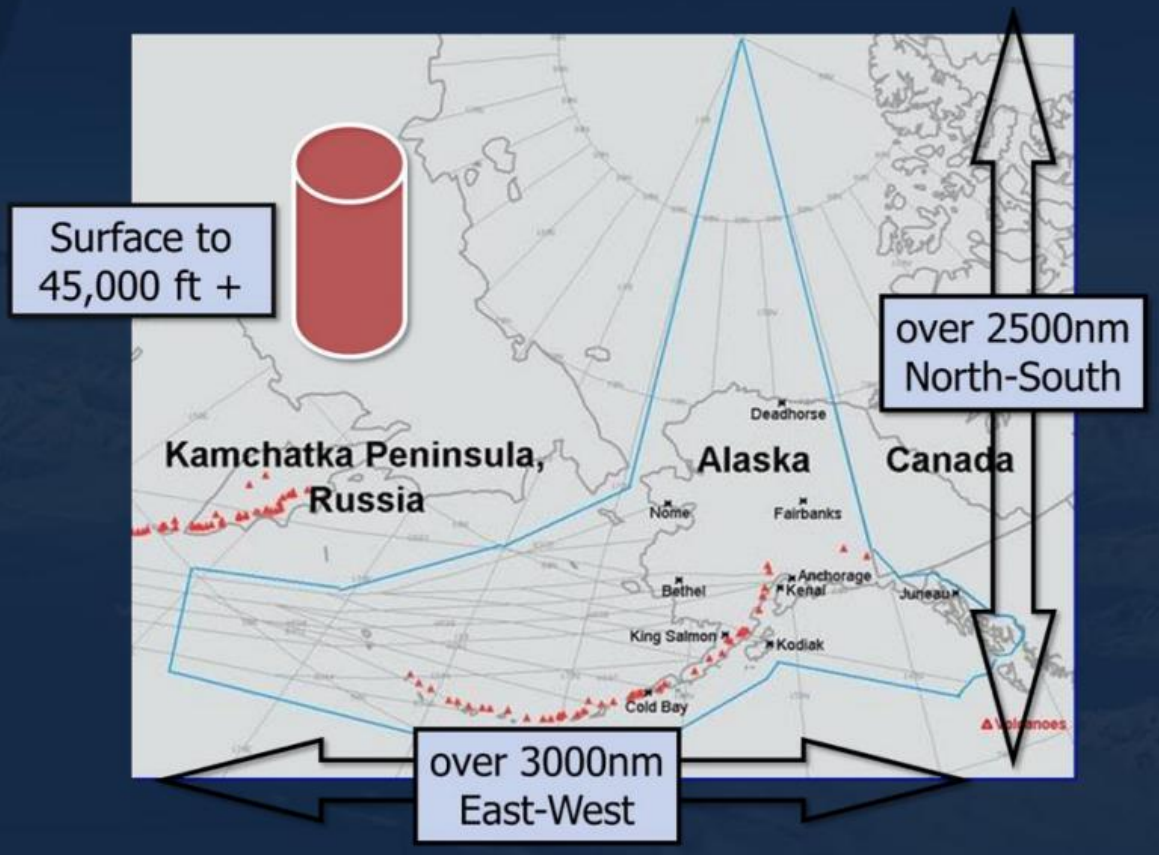


NWS Alaska Region Overview

Alaska Aviation Weather Unit (AAWU)

Alaska Aviation Weather Unit (AAWU)

- Forecasts for over 2.4 million sq. miles of airspace
  - Graphics, Area Forecasts, AIRMETs, and SIGMETs
  - Flight Category, Icing, Turbulence, Convection, Surface Analyses, and Volcanic Ash
- Need for a strong internal collaborative forecast process
- Close partnerships with FAA, industry, and formal associations to help guide services

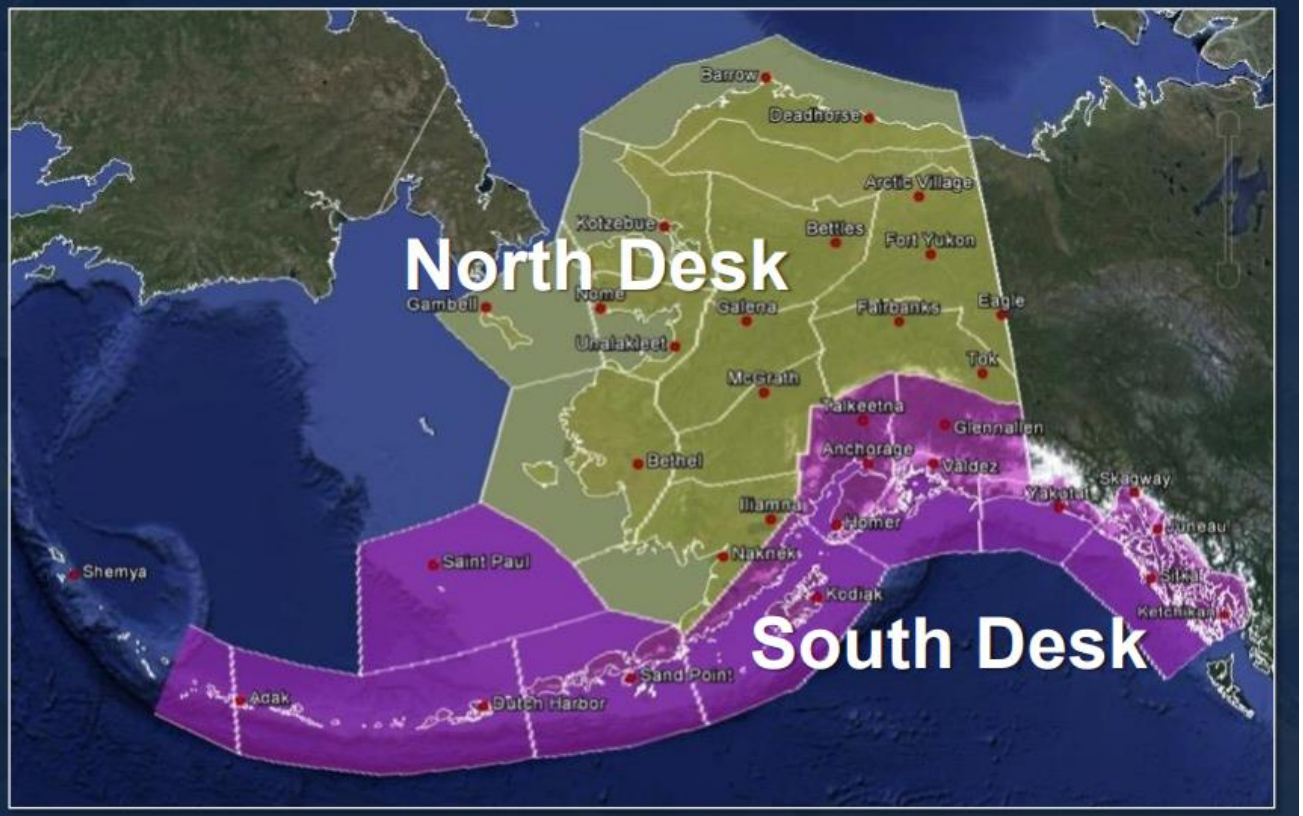


AAWU Forecast Responsibility

Alaska Aviation Weather Unit (AAWU)

North Desk:
- 12 Area Forecasts
- Freezing Levels
- Icing
- Convection
- Flight Category

South Desk:
- 13 Area Forecasts
- Surface wind
- Low-level Turbulence
- High-level Turbulence
- Surface Analysis

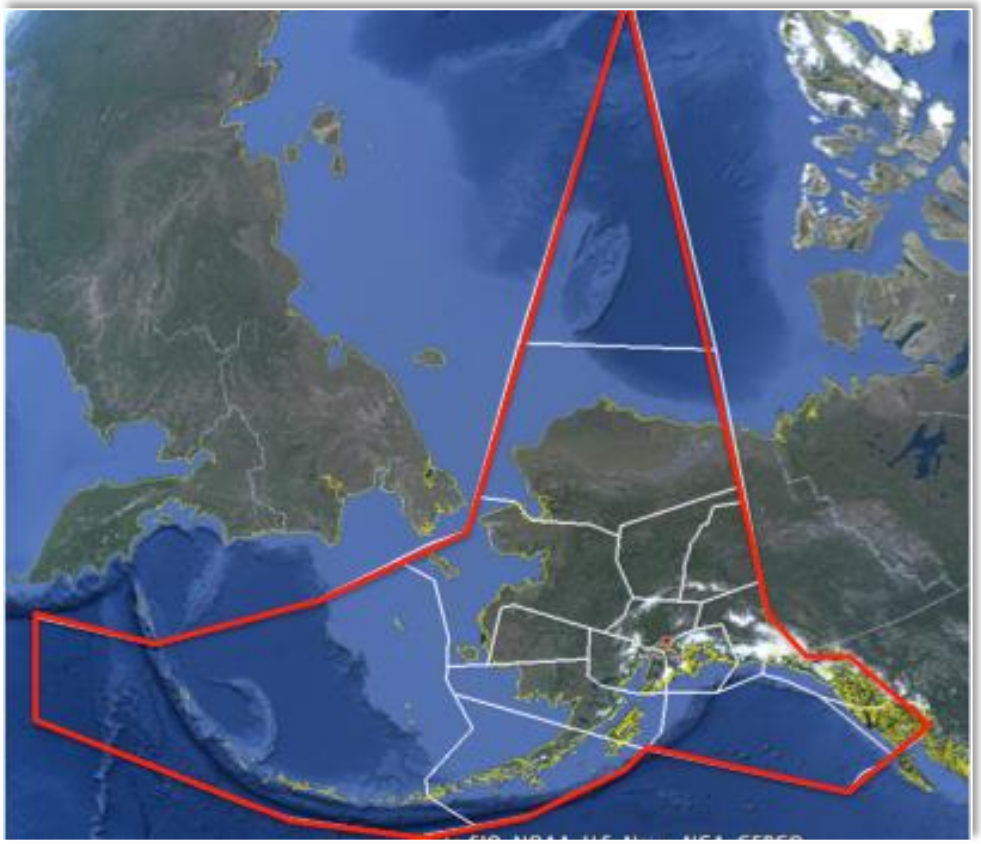


Anchorage Center Weather Service Unit

ZAN CWSU Area of Responsibility

- ZAN Flight Information Region covers 2.4 million square miles
  - = Approximately the area covered by 13 of the 20 Lower 48 CWSUs

- Borders Russian, Japanese, Canadian, and U.S. (Oakland) FIRs



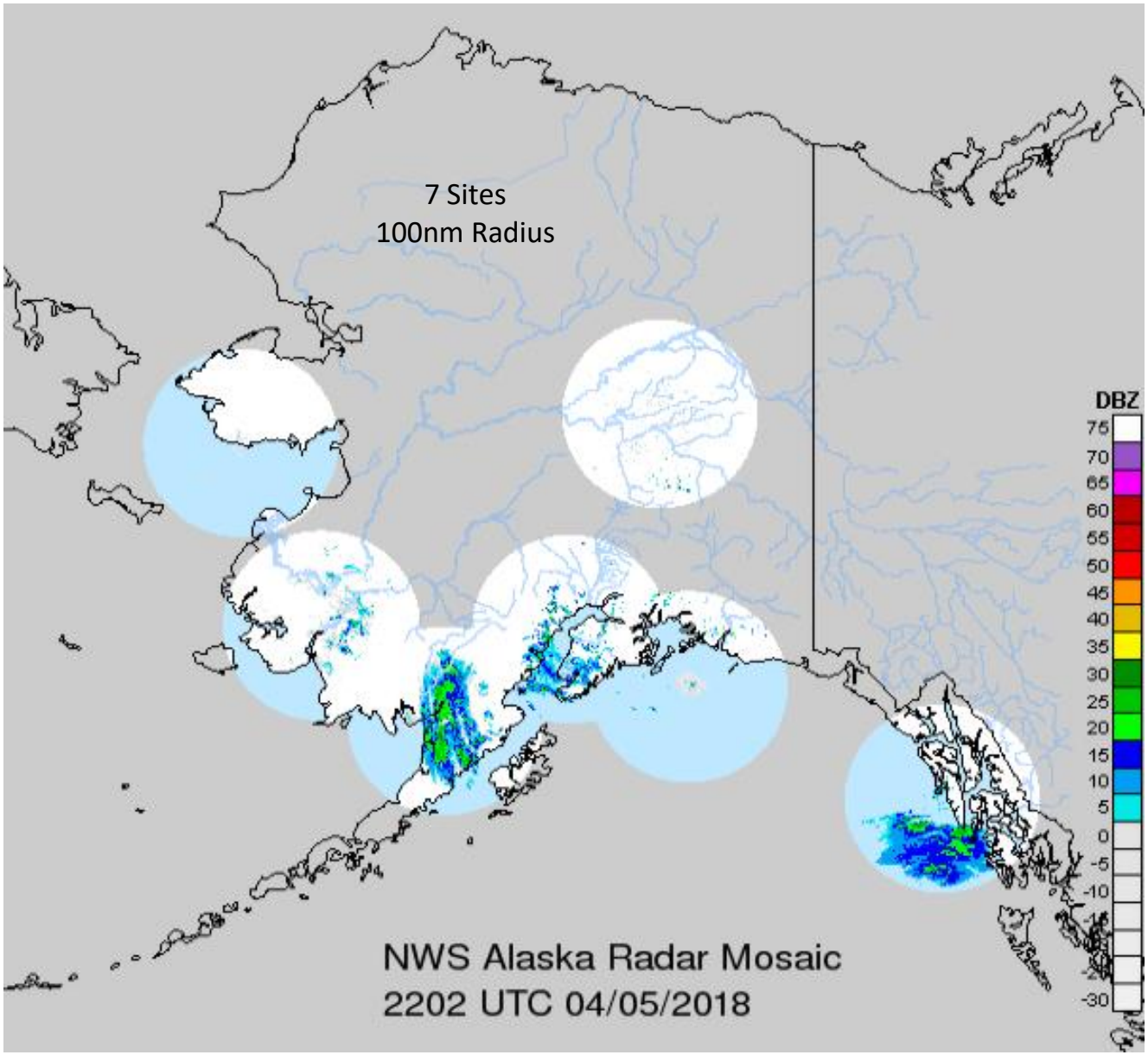
Federal Aviation Administration

FAA Flight Service Briefing Tools

- Surface Charts
- Weather Prognostic Charts
- Satellite Imagery
- NEXRAD Radar
- Weather Cameras
- Pilot Reports

Alaska Flight Service Station Facilities

NEXRAD Weather Radar



Private Pilots

- Tom George
  - FAA ratings and certificates: Commercial Pilot, Single Engine Land, Single Engine Sea, Multi Engine Land, Instrument Airplane. Also Flight Instructor, Airplane Single Engine
  - Over 4,300 hours flight time, almost exclusively in Alaska. Fly a single engine aircraft, VFR In the past have flown supercubs in off-field operations, today fly a Cessna 185 for business travel, and to collect aerial photography and other data. Mostly operate in Interior, north slope, south central parts of the state.
  - Work for the Aircraft Owners and Pilots Association, a national organization advocating on behalf of pilots and aircraft owners who fly for non-commercial purposes such as private business, government or recreational activities.

Private Pilots

- Adam White
  - Has the following FAA ratings and certifications: Commercial Pilot
    - Single Engine Land
    - Single Engine Sea
    - Multiengine Land
    - Instrument Airplane
    - Flight Instructor
    - Airplane Single Engine
    - Instrument Airplane
    - Mechanic
    - Airframe and Power plant
  - I have 4500+ hours flight time in the past 28 years, 95% of it in Alaska. I primarily fly VFR, single engine, below 10K' and just about every flight involves off-airport operations. I fly floats and wheels in the summer season and skis and wheels in the winter with a Maule M7 and a Cessna 206. While I do fly IFR occasionally, the infrastructure in Alaska doesn't really support IFR operations in remote, off-airport situations. Most of my flights are in the Interior and Northwest Arctic regions of the Alaska. Because I fly in remote, off-airport situations I find it difficult to get an accurate and complete weather picture for flight planning.

NOAA Arctic Test Bed and Proving Ground

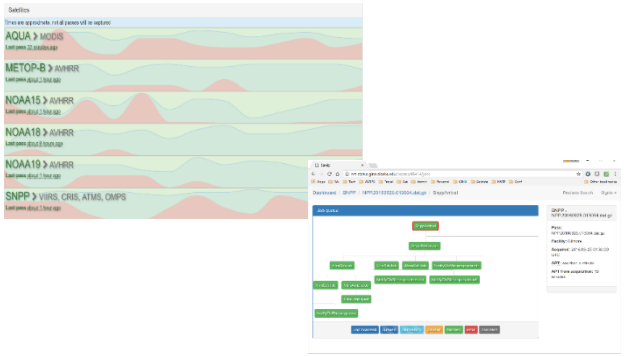
Test Bed Specifics

- Purpose
  - Located at NWS Alaska Region HQ, Anchorage. Part of Environmental and Scientific Services Division (ESSD) & the NWS Science and Technology Integration (S&TI) Portfolio
  - Focus NWS Alaska Region development efforts to maximize service delivery effectiveness in Alaska
  - Facilitate and improve (R2O, O2R, and O2O) of new and improved products and services that fulfill current and emerging decision-support requirements
- Capabilities:
  - Integration with NWS forecast systems & data streams, and research data streams
  - Ability to simulate operations with archived data in AWIPS
  - Test generate new products or services in real-time or during simulation
- Synergistic Opportunities
  - Connecting the research community with NWS operations in Alaska
  - Potential to evaluate new datasets directly in operations or in a simulated environment
- Expectations
  - Model and data assimilation improvements to operational models for sea ice forecasting
  - Working with satellite partners to bring new capabilities to the Alaska Sea Ice Program and all of our forecast programs (Marine, Hydro, Aviation, Public, Fire Weather)
  - Evaluate and assimilate new forecast data, methods and procedures into operations

Geographic Information Network of Alaska (GINA)

University of Alaska Fairbanks

NESDIS/FCDAS
Gilmore Creek, AK



The Geographic Information Network of Alaska (GINA) located on the University of Alaska Fairbanks campus receives polar satellite data from several downlink resources via Direct Broadcast. Using redundant systems GINA is able to processes and deliver polar satellite data in Near Real Time (NRT) to the National Weather Service and other government agencies in Alaska.

Direct Broadcast satellite processing is made possible by CSPP software provided by CIMSS
http://cimss.ssec.wisc.edu/cspp/

Aviation Initiative Goals

- Establish an Alaskan User for the cloud macrophysical (vertical structure) products included in the new CCL formulation.
- Build relationships for perhaps extending into other products where people expressed interest:
- Develop a sense of the utility of JPSS products compared to the current AAWU product suite (IPA, CIP, FIP) from NCAR and FAA. Use feedback to motivate collaboration with those groups.