

# The 557th Weather Wing



## Arctic Environmental Threats to Military Facilities, Operations, and Planning



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Overall Briefing Classification: **Unclassified**

INFORMATIONAL

*WEATHER DRIVES BEHAVIOR*

24-26 May 2022



# Overview



- **The 14th Weather Squadron**
- **Background**
- **Motivation**
- **Current Capabilities**
- **Static Arctic Products**
- **Dynamic Arctic Products**
- **Gaps**
- **Summary**



# 14th Weather Squadron

*Mission: Collect, protect and exploit authoritative climate data to develop competitive advantages for the DoD, Intelligence Community, and NATO*



*Vision: Provide a competitive edge via the most advanced authoritative climate data and exploitation*



# 14<sup>th</sup> Weather Squadron Background



- **Comprised of 3 flights: Operations, Data, and Systems**
- **Operations split between Support Analysis Request (SAR) team and the Climate Monitoring, Analysis, and Prediction (CMAP) team**
  - SAR – customer focused; specialized products and reports
  - CMAP – wider/global focus; larger scale products; prediction outlooks for sub-seasonal to seasonal scales
- **Data has 2 teams, Ingest and Quality**
  - Ingest – maintains the flow of data into the squadron and archives into our historical database
  - Quality – QA/QC for historical database; creates Operational Climate Data Summaries (OCDS)
- **Systems is comprised of Software Engineering/Configuration management, Cyber Support and Cyber Security teams**
  - Software Engineers – maintain 370k lines of Gov't unique software, shapes DevSecOps
  - Cyber Support – maintains AFNET connectivity, administrates 80 servers/176 STIG checklists
  - Cybersecurity – Maintains Risk Management Framework across 3 enclaves



# Motivation

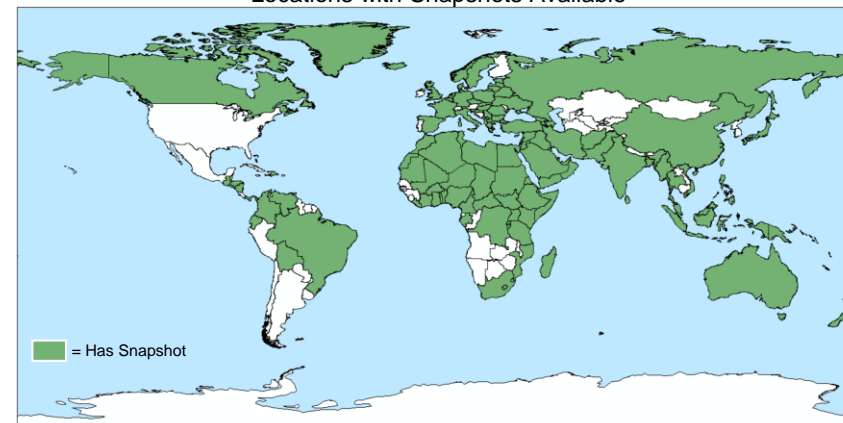
- **A growing demand from the field and partners for Arctic weather observations and outlooks to support Tactical and Operational missions alongside strategic planning**
  - **Support Analysis Requests requiring information for planning, resource allocation and operational risk assessment regarding military operations and exercises**
    - Field units looking to help posture for operations in coming days, months, and years
    - Assess severe weather risk, prepare for changing arctic environment
    - Plan/conduct construction and infrastructure hardening to include optimization of both flight and ground maneuvers around weather limitations
  - **Headquarters planners, research organizations, local units**
    - Weather-related trade-offs between locations, prioritization for construction, design and limitations of current and future systems
    - Interest for strategic planning and war gaming



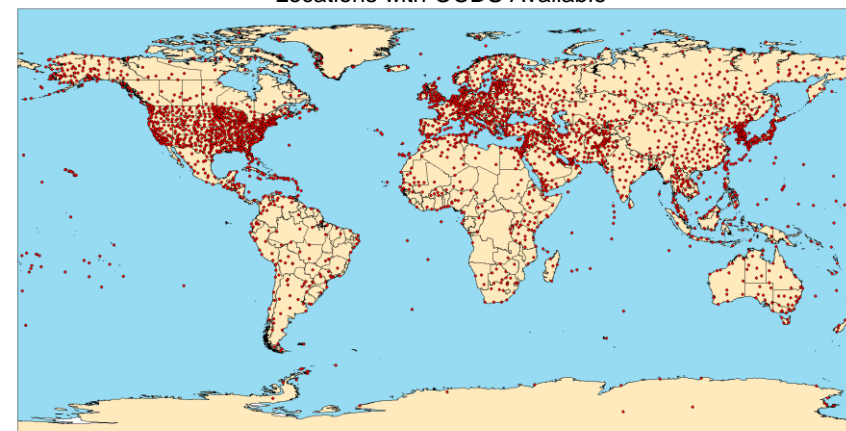
# Arctic Capabilities

- **Static Products (Available on the Web)**
  - Arctic Climate Assessment
  - Country/Regional Snapshots
    - Arctic regions available: Alaska (USA), Northern Canada, Iceland, Norway, Sweden, Russia,
  - Operational Climate Data Summary (OCDS)
    - Station based dataset
  - Standard Products
  - Arctic Monitoring & Prediction
- **Dynamic Products**
  - Weekly Brief Arctic Slide
  - Examples of SARs pertaining to the Arctic region

Locations with Snapshots Available



Locations with OCDS Available





# Arctic Climate Assessment

- ❖ Motivation: SAF/IE request
- ❖ Published: 26 Aug 2021

- Document that identifies impactful weather conditions within 50 miles of the main operating bases
- Includes both quantitative and analyst-in-the-loop analysis of weather and climate threats and regional narratives
- Commands: EUCOM and NORTHCOM (North of 60° North)

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An empirical analysis of weather and climate threats in the Arctic.  
Date: 9 August 2021 — Updated 26 August 2021

## Arctic Climate Assessment

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### Installation Threat Assessments

Aviation	Flood	Wind	Severe TS	Winter	Heat	Wildfire
Moderate	Low	Moderate	Low	High	Low	Low

Aviation	Flood	Wind	Severe TS	Winter	Heat	Wildfire
Moderate	Low	High	Low	High	Low	Low

The main hazards at [redacted] are winter weather, wind, and aviation hazards.

**Winter Weather:** Temperatures below 32°F (0°C) are common year-round, and August are the only months when temperatures can stay above freezing.

- Average temperatures range from the mid-30s°F (3°C) in July, and August to the mid-negative 20s°F (low -30s°C) from December through March.
- From November through April, morning low temperatures are typically below -20°F (-29°C). Temperatures can reach or exceed 0°F (-18°C) from January through March.
- Wind chills are at or below 0°F (-18°C) during the time from November through April.
- Precipitation is light near [redacted]. October through June is a dry period.

**Wind:** From January through August, prevailing winds are northerly, averaging 4-9 knots. Peak wind speeds reach 50-70 knots. The winds shift to southerly from September through November with average speeds of 10-15 knots with gusts of 6-8 knots.

**Aviation:** From May through September, IFR conditions occur 20% of the time. Visibility conditions are poorest in May and August.





Figure 11. South facing view of the Canadian Forces Station

### Regional Narratives

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#### Alaska

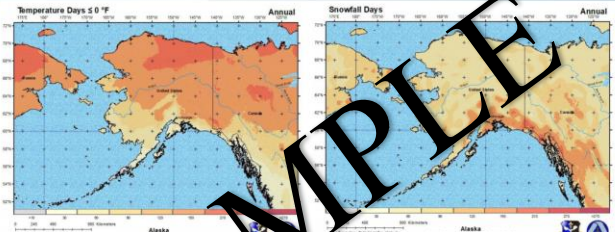


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#### Alaska

Temperature Days ≤ 0 °F Annual

Snowfall Days Annual

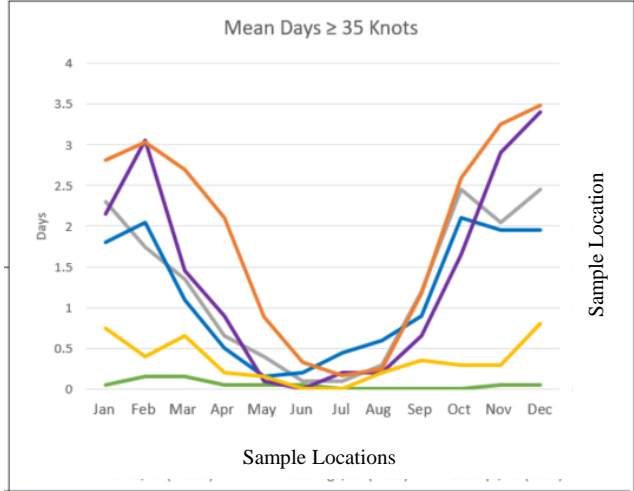




# Country/Regional Snapshot: Alaska



- **Snapshots typically include:**
  - Country/Region Overview
  - Key impactful weather parameters
  - Notable hazards for the region
  - Seasonal Precipitation Timeline
  - Important Teleconnections
  - Operational Impacts
  - Planning Considerations



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## Climatic Snapshot Alaska

Key weather parameters that impact operations:  
**Snow / Temperatures, Low Ceilings/Visibility and High Winds**  
 Military operations will also be impacted by low ceiling, low visibility, low temperatures, strong low-level inversions, poor trafficability, and wildfires

**Overview:** This northern and western most state in the continental United States extends over 300 miles north of the Arctic circle. The Alaska frontier is marked by unfavorably frigid and isolated conditions spanning from the Kenai Peninsula north through the desolate interior into the far reaches of the Arctic Tundra. This remote wilderness is influenced by interactions between arctic, continental air masses and transitory systems that bring cold rain, snow, and sub-freezing temperatures. The northern reaches of Alaska can be impacted by transitory storms as they move north out of the Bering Sea and associated precipitation resulting from the orographic lifting found across the Brooks Mountain Range. The western coastal climate can have heavy precipitation with a general decrease in precipitation moving south to north. Interior areas have both some of the warmest and coldest temperatures found throughout the state. In the southern region, much of the precipitation results from a moist southerly upslope flow coupled with day-time heating.

**Significant Weather Phenomena:**  
 Snowstorms and blizzards with near zero visibility at times, extreme cold temperatures, extreme wind chills, river flooding, avalanches, landslides, strong inversions, and wildfires

**Climatic Controls:** Aleutian Low, El Niño/La Niña, North Pacific Oscillation, Pacific Decadal Oscillation (PDO), Sea Ice, Polar Jet, Arctic Oscillation

Seasonal Precip Timeline	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
North Slope		Dry		Snow		Rain				Snow		
Interior		Dry		Snow		Rain					Snow	
Western Coast						Rain					Snow	
Cook Inlet						Rain				Snow		
Aleutians							Rain				Snow	
Gulf							Rain					Snow

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Date created: 10 December 2021

Sample: Weather Threat Assessment

Operation	Dec-Mar	Apr-May	Jun-Sep	Oct-Nov
Fixed Wing	Turb Cig Wind	Cig Vis Wind	Cig Vis Wind	Cig Vis Wind
Rotary Wing	Turb	Cig Vis	Cig Vis	Cig Vis
ISR	Turb Wind Temp	Cig Vis Wind Temp	Cig Vis Wind	Cig Vis Wind Temp
Ground Ops	Temp	Cig Vis Temp	Cig Vis	Temp





# OCDS



OCDS locations above 60°N

- **Operational Climate Data Summary**
  - Available for 199 of sites above 60°N
  - Uses a 10 year climatology for mean data
  - Data is available for download
  - Climograms (visual summaries of data) available for all stations

Sample: Climate Summary for a Base

Location: Base XX

UTC to LST: -4

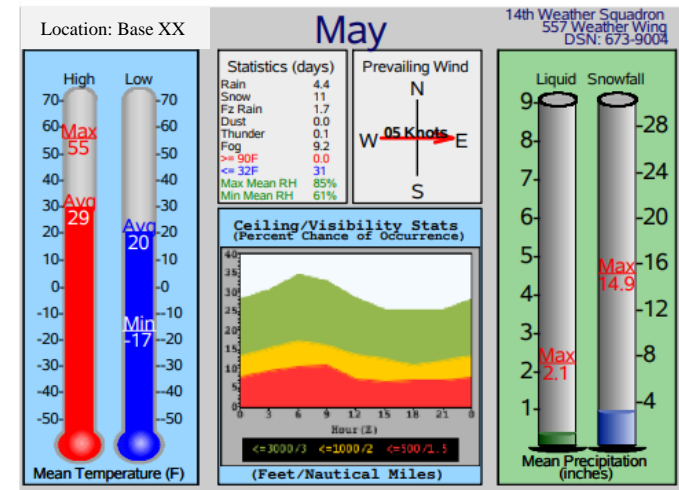
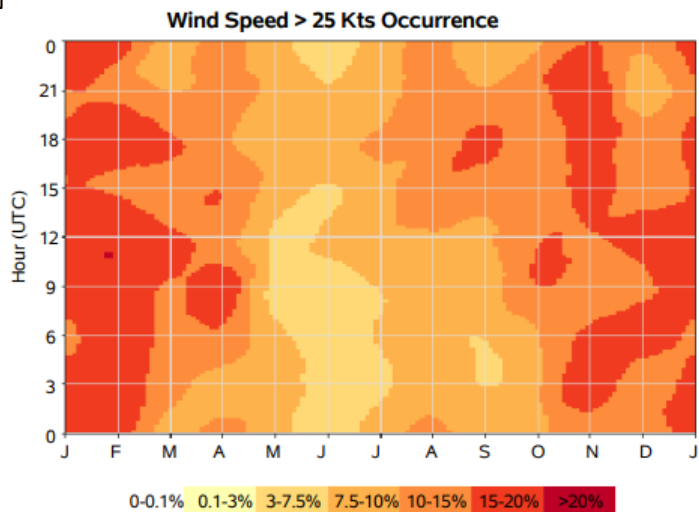
POR (Mean): 2011/01/01 - 2020/12/31      POR (Extreme): 1951/09/01 - 2022/01/31      PREPARED BY: 557 WW / 14 WS

POR (Detailed): 1951-1970, 1973-2021

YEARS: Period of Record (see mean POR >>>)

Authoritative climate summary - data quality and quantity sufficient to produce accurate climatological values

Get Climogram    Download as CSV    Download as Text





# Standard Products



## Airfield Reliability

- Reports on reliability of airfield operations
- Winds, ceilings, precipitation, temperatures, thunderstorms

## Engineering Weather Data (EWD)

- Summarized station information for design, construction and maintenance of buildings
- Dry/wet bulb temperatures, humidity ratio, degree days, latent/sensible heat load, winds

## Modeled Diurnal Curves

- Daily summaries of variables by the hour
- Temperature, dew point altimeter, relative humidity, pressure altitude

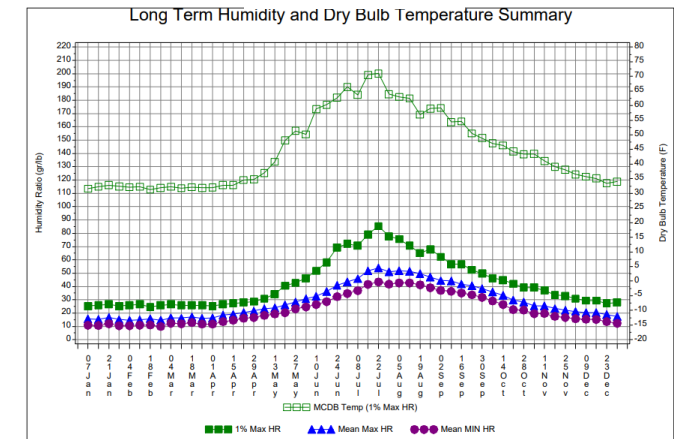
## Surface Wind Roses

- Monthly plots of wind speed and direction

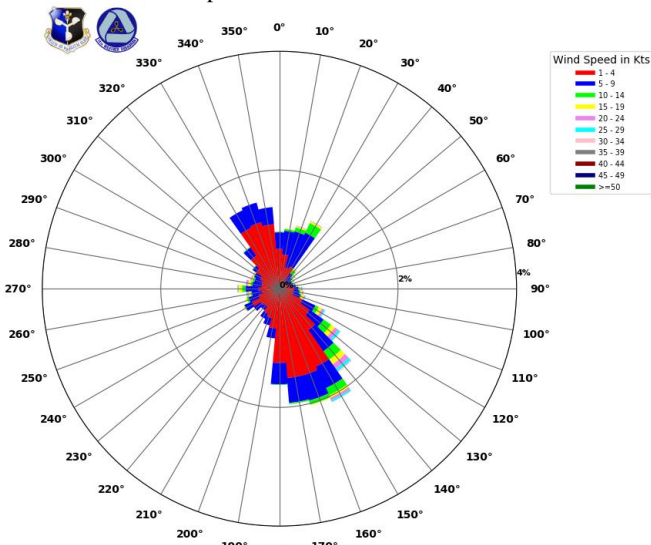
## Wind Stratified Conditional Climatology (WSCC)

- Likelihood of ceiling or visibility conditions for the hour by month

Sample: EWD

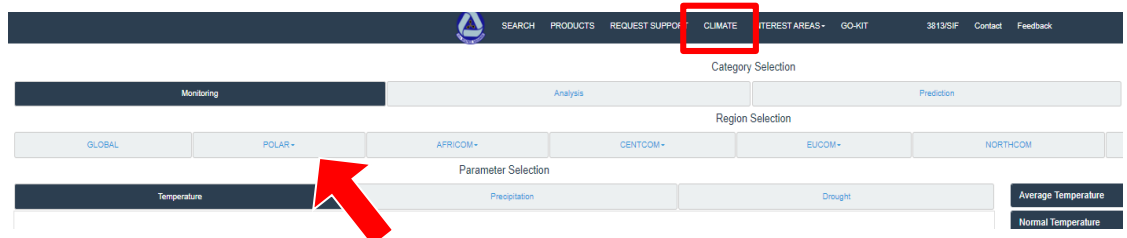


Sample: Surface Wind Rose





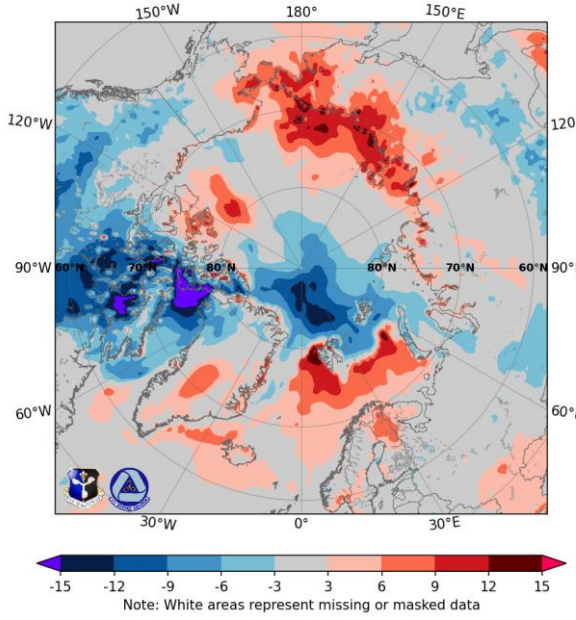
# Arctic Monitoring & Prediction



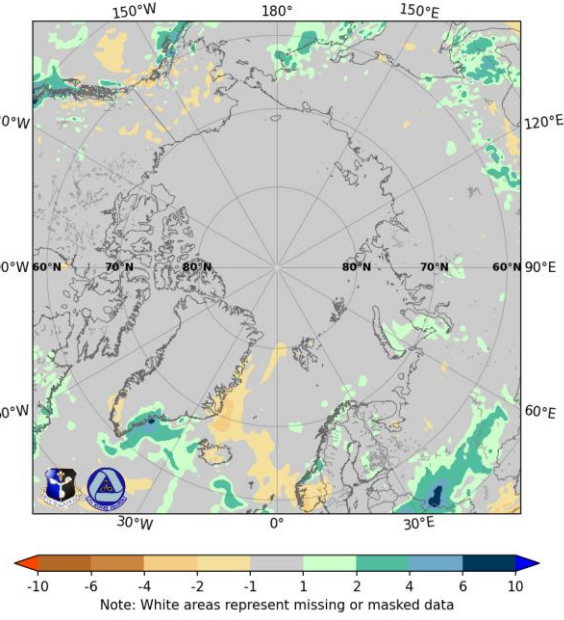
<https://climate.af.mil/>

## Monitoring: Temperature & Precipitation

Sample: 7-day Temperature Anomalies (°F)

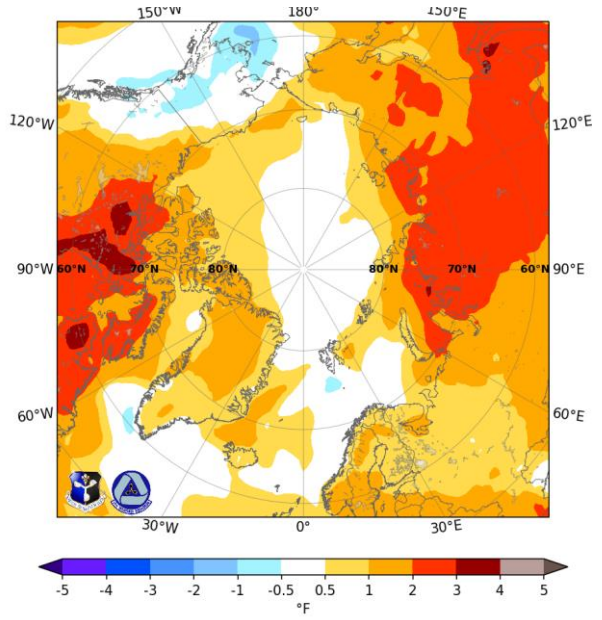


Sample: 30-day Precipitation Anomalies (in)

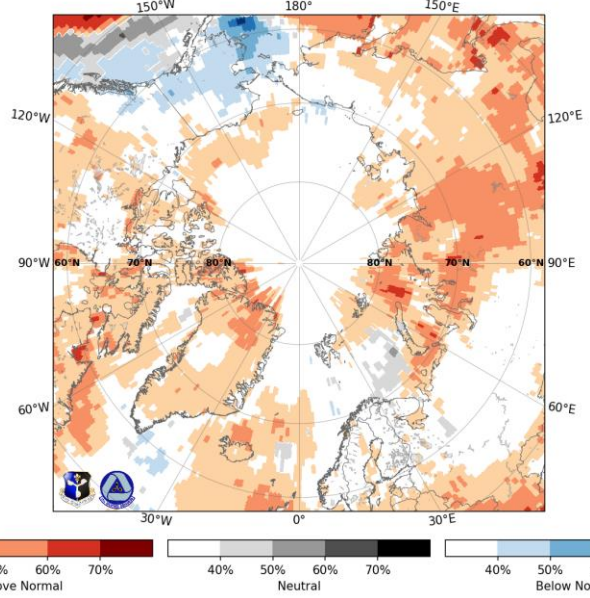


## Prediction: Temperature, Precipitation, Wind, 500mb Heights

Sample: 3-month Air Temperature Anomaly Forecast (°F)



Sample: 3-month Air Temperature Probability Forecast (°F)



Source: Climate Data Assimilation System (CDAS) NOAA

Source: North American Multi-model Ensemble (NMME)



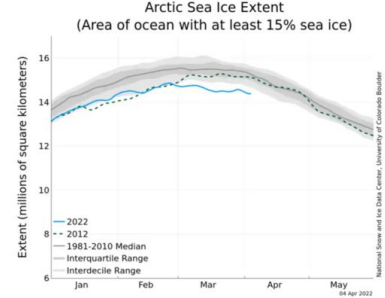
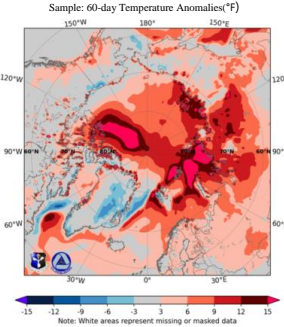
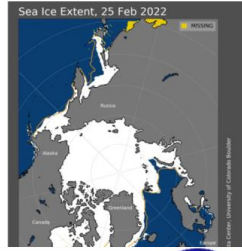
# CMAP Weekly Brief

## Weekly climate brief

- General overview of influential teleconnections, global prediction for week-3 and model verification
- Includes spotlight slides for each co-com and the Arctic



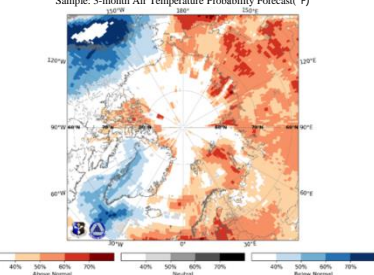
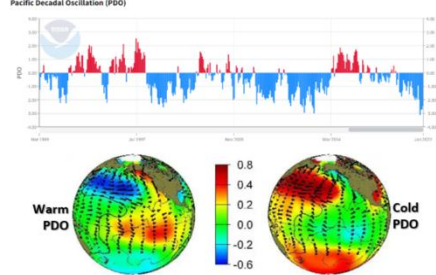
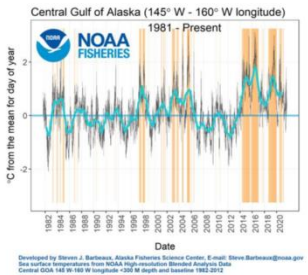
## ARCTIC



reached its peak on 25 Feb, and rounded out as the tenth lowest maximum extent on record and the third earliest date for extent was lower than average in the Gulf of St. Lawrence, Sea of Okhotsk, and the Barents Sea, but above average near Greenland sea ice extent is notable; above normal temperatures and a heat wave did also impact the Arctic during March, with temperature



## ARCTIC



**WHAT OCCURRED:** Alaska's historic salmon runs in the Yukon River, which support a global industry as well as local communities, have experienced poor yields due to more frequent marine heat waves during past years. The Pacific Decadal Oscillation (PDO) has been mostly cold (negative PDO) since 2017 across the Northeast Pacific.

**WHY THIS IS IMPORTANT:** Cold, fresh waters are necessary for the salmon industry, and for the past several years, marine heat waves in the Gulf of Alaska and Bering Sea have led to major salmon die offs. Research has found that water temperatures above 64°F lead to stress and death for the salmon population. Commercial fishers and the local indigenous communities depend on this resource for their livelihoods and subsistence. A disaster has been declared by the US government after record losses in 2020 and 2021, making relief funds available to the fishery industry. Mantua (2009)<sup>1</sup> showed that a cold PDO leads to decreased salmon production in Alaska and vice versa.

**OUR PREDICTION:** Salmon season typically starts around May. Temperatures for the region have been well above average for the past few weeks; however, seasonal predictions from the NMME indicate that temperatures are forecast to return to below normal for much of the spring season. This would hopefully limit early season warming to the interior waterways. Other model guidance supports this seasonal prediction. **Confidence: Moderate.**

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<sup>1</sup> Mantua, N.J., 2009: Patterns of Change in Climate and Pacific Salmon Production. American Fisheries Society Symposium.

## Teleconnections Discussed

- Arctic Oscillation (AO)
- North Atlantic Oscillation (NAO)
- Pacific North American Pattern (PNA)
- Antarctic Oscillation (AAO)

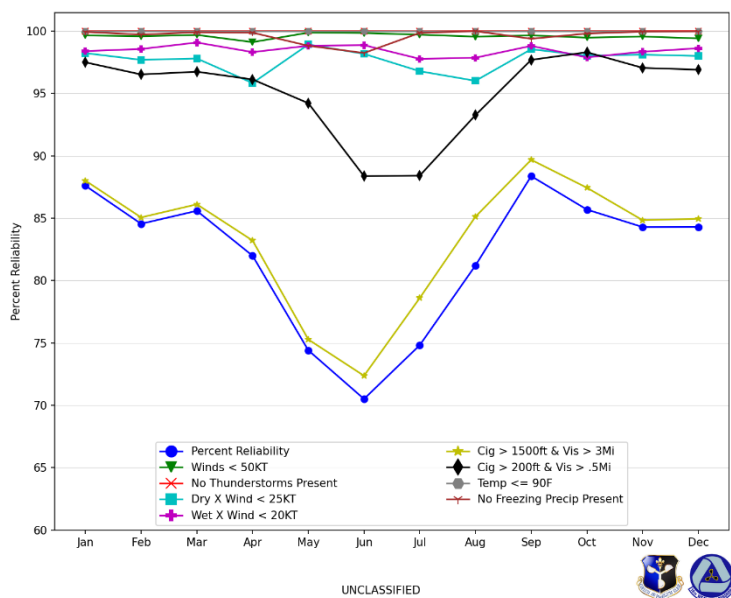


# SAR: Flight/Ground Operations Planning



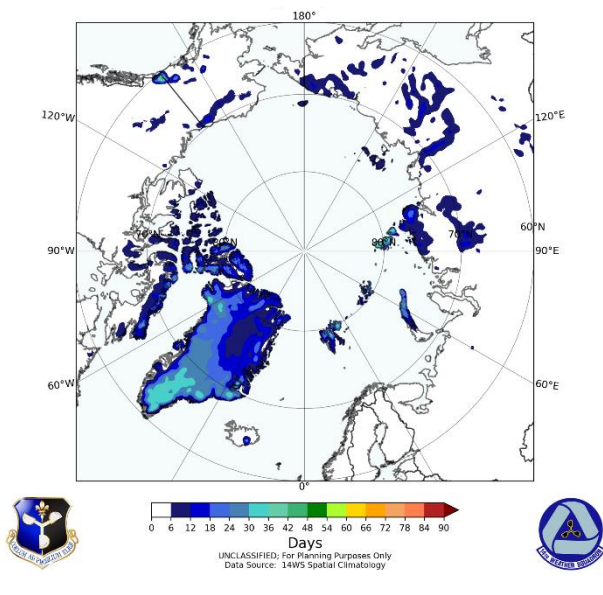
- Requests for products to aid in operations planning for operations for Thule, Greenland
- Airfield Reliability Reports- monthly percentages of airfield thresholds
- Mean number of days with snow and ceilings less that 1500 ft

Sample: Airfield Reliability Report



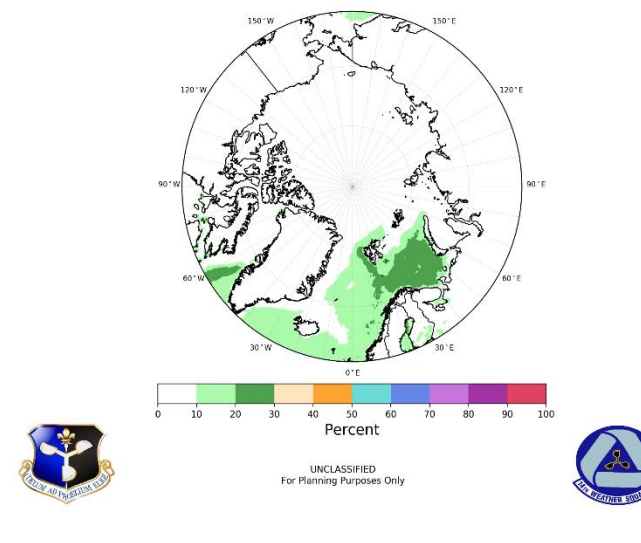
Air Field Reliability Report, Surface Data, Support Assistance Request (SAR), 2022

Sample: 3-month Mean Number of Snow Days in Season



Mean Number of Snow Days Jul-Sep, Spatial Data, Support Assistance Request (SAR), 2021

Sample: 1-month Frequency of Ceiling less than 1.5kft



Ceilings <1.5 ft Jul-Sep, WWMCA, Support Assistance Request (SAR), 2021

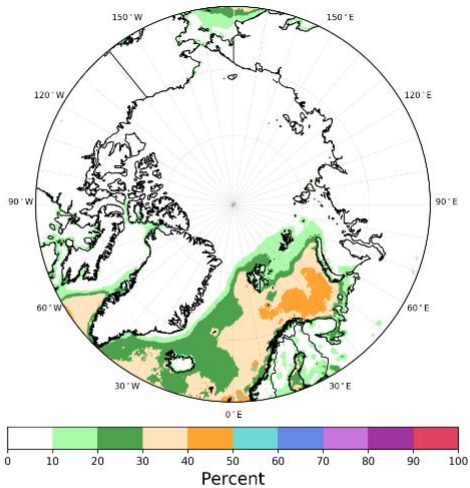


# SAR: Future Naval Arctic Operations



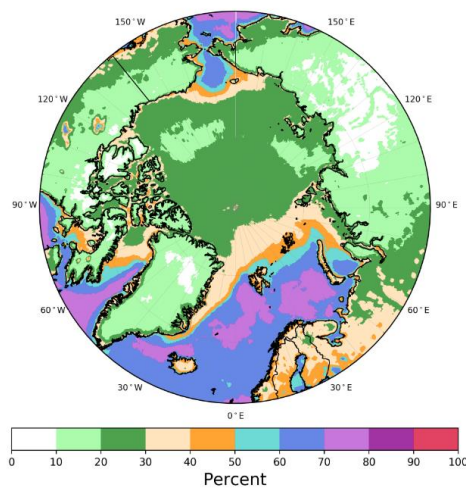
- Requests for products to aid in future Arctic operations for Commander U.S. Second Fleet
- Frequency of low cloud/month < 1500ft, <3000ft, <5000ft, and mean total cloud amount (WWMCA)
- Total Cloud, 6-hour average (CFSR/V2)

Sample: 1-month Frequency of Ceiling less than 5kft



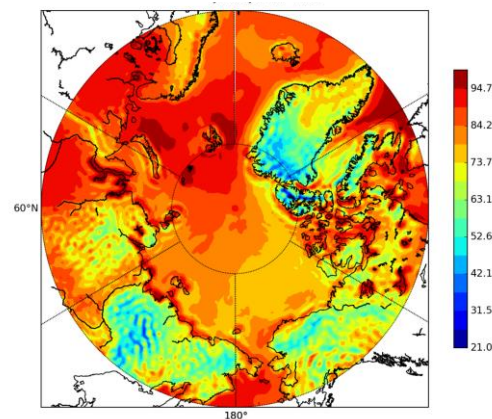
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Sample: 1-month Mean Total Cloud Amount



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Sample: CFSR/V2, 1-month Global Mean Total Cloud Amount, over 37yrs



Above Map is Presented in a North-Polar Stereographic Projection



Ceilings <5 ft Jan, WWMCA, Support Assistance Request (SAR), 2019

Mean total cloud Nov, WWMCA, Support Assistance Request (SAR), 2019

Total Cloud Cover Jan, WWMCA, Support Assistance Request (SAR), 2019



# Gaps



- **Projection (yearly to decadal)**
  - Limited to a week 3 – seasonal timescale for prediction with current data
  - Lack of expertise within squadron
  - Require more computing resources for this timescale
  - Climate models performance in Arctic regions
  - Drivers in Arctic climate
- **Prediction (3 weeks-one year)**
  - Model deficiency in polar latitudes
- **Observation Density**
  - Lack of in-situ/upper-air data



# Summary



- **14<sup>th</sup> Weather Squadron tasked to help answer numerous operational and strategic questions from a climatology perspective for the Arctic**
- **Leverage internal and external data sources to produce products**
- **Current products give users the ability to analyze critical risks to operations and strategically plan on sub-seasonal and seasonal timescales**
- **Gaps in climate projection capabilities for the 14 WS limit the ability to address long (multi-year/decadal) term planning requests from the DoD, the intelligence community, and international partners**





# Questions?