Current Operational ACNFS and its use at the U.S. National/Naval Ice Center (USNIC)

Sea Ice Prediction Workshop
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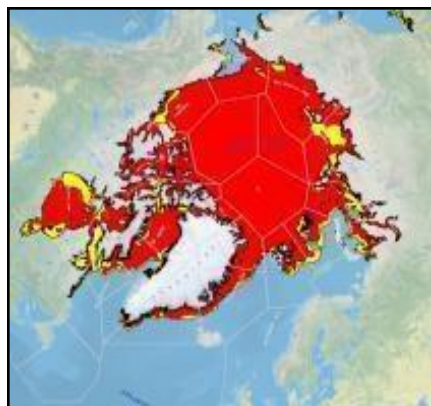[3] *QinetiQ North America*

USN

USCG

NOAA

U.S. National/Naval Ice Center (USNIC)

A multi-agency operational center operated by the United States Navy, National Oceanic and Atmospheric Administration, and United States Coast Guard providing direct operational support to COMSUBFOR, USN, USCG, FWCs, NOAA and NSF Ships.

- Co-Located with NOAA/NESDIS in D.C. Metro area
- GLOBAL sea ice analysis and forecasting
- National and International Sea Ice and Meteorological Partnerships, including Canadian, Norwegian, Russian and other Ice Services
- Unclassified and Classified Support : COMSUBFOR, Arctic Submarine Lab (ASL), ONI, NOAD, FNMOC, NRO, NMIC, and NGA….
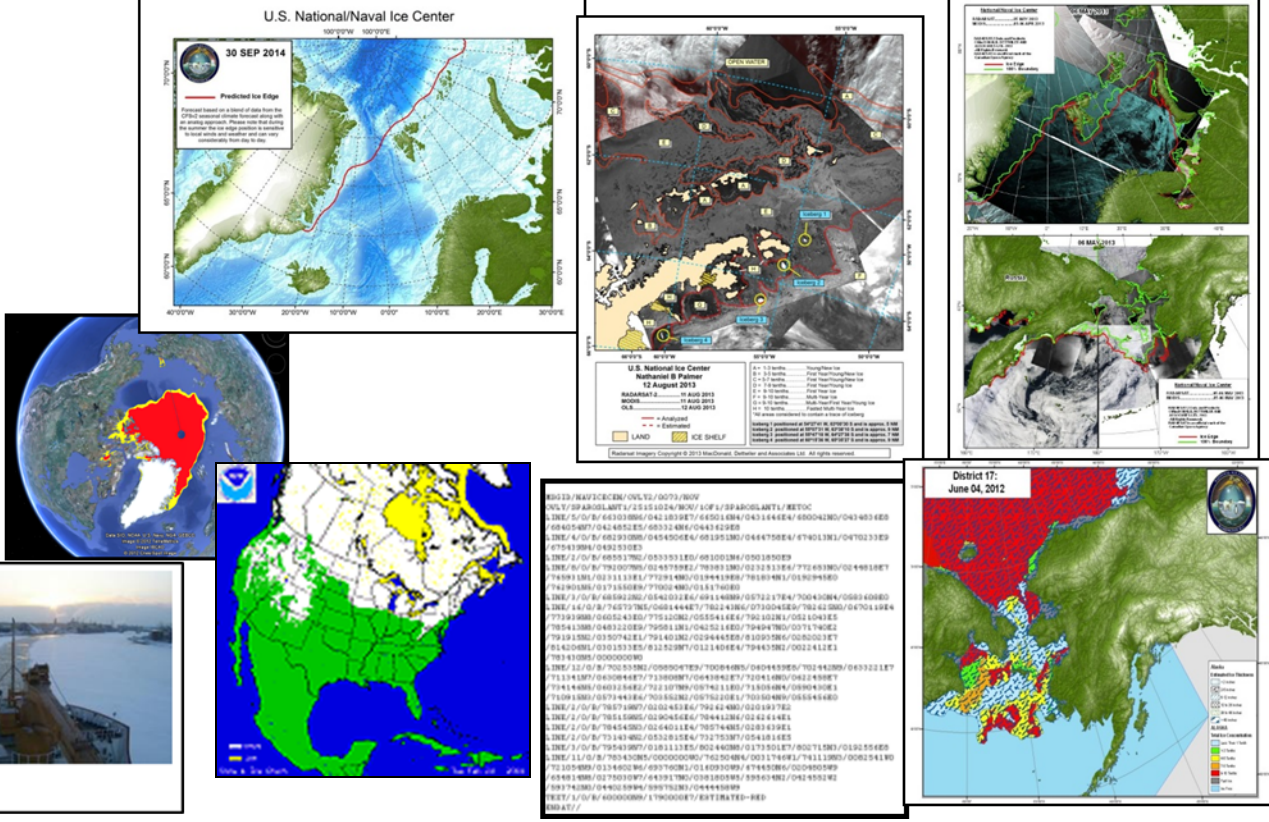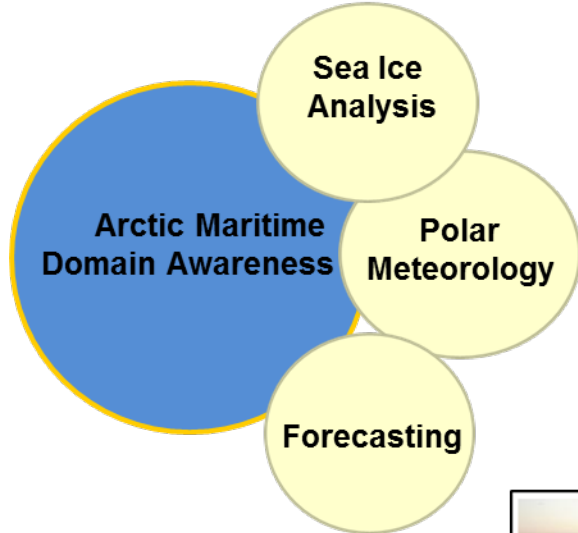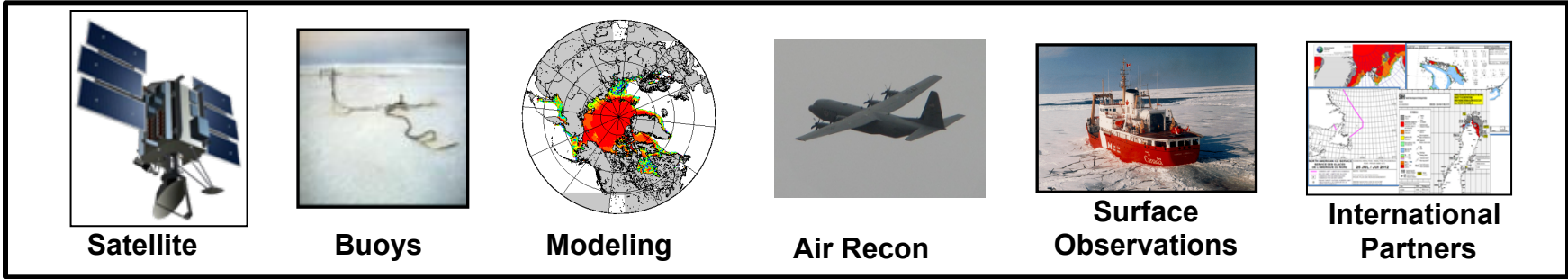
Mission: Provide global ice and snow (including the Great Lakes and the Chesapeake and Delaware Bay systems) analysis and forecasting services for the maximum benefit of United States government interests.

Coverage 20.6 Million Square Miles – Arctic, Antarctic, and Great Lakes

Product Generation

Satellite

Buoys

Modeling

Air Recon

Surface Observations

International Partners

Arctic Maritime Domain Awareness

- Sea Ice Analysis
- Polar Meteorology
- Forecasting

Limitations to seasonal scale sea ice forecasting:

(1) high variability in atmospheric and oceanic influence
(2) observations for initialization and validation have limited coverage and/or high uncertainties
(3) limitations of current model capabilities
(4) inherent limitations in sea ice predictability
(5) an Arctic system changing in ways without recent historical precedent.

Rush to improve ability to predict characteristics of sea ice cover in order to better model the future of ice cover.

U.S. Navy Arctic Roadmap

The US Navy, as the maritime component of the Department of Defense, has global leadership responsibilities to <u>provide ready forces for current operations and contingency response that include the Arctic Ocean</u>

In support of National and Department of Defense aims, the <u>Navy will pursue the following strategic objectives:</u>

    -Ensure United States Arctic Sovereignty and provide homeland defense;

    -Provide <u>ready naval forces</u> to respond to crisis and contingencies;

    -Preserve freedom of the areas; and

    -Promote partnerships with the U.S. Government and with international allies and partners.

Near Term: Today – 2020 - Mid Term: 2020-2030

USNIC Support USN Arctic Roadmap

Operational expertise
Near-real time analysis of imagery sources
Heuristic/empirical knowledge of behavior of sea ice
Daily monitoring of Arctic and Sub Arctic Regions
Knowledge of limitations of modeling in area
Collaboration with modeling communities
Climatological/Planning capability
On board experience
Understanding and involvement USN (active duty)
Well established international partnerships

- **Leverage and fuse these capabilities into relevant tactical products and expertise in the Arctic for operational sea ice analysis; forecasts for sea ice and synoptic polar weather; modeling validation and data assimilation; and input to OTSR for USN, USCG, NOAA government vessels operating north of 66N and south of 66S**

- **Increase operational expertise now in order to enable USN to provide the right capability at the right time.**

Primary Applications for ACNFS at USNIC

1. Provides additional guidance for 48-hr Ice Edge Forecast Requirement (SUBFOR)

2. Provides additional information for special support customers

3. Additional resource for Hemispheric Ice Analyses

4. Use in hindsight to determine where NIC forecasts could improve for future predictions
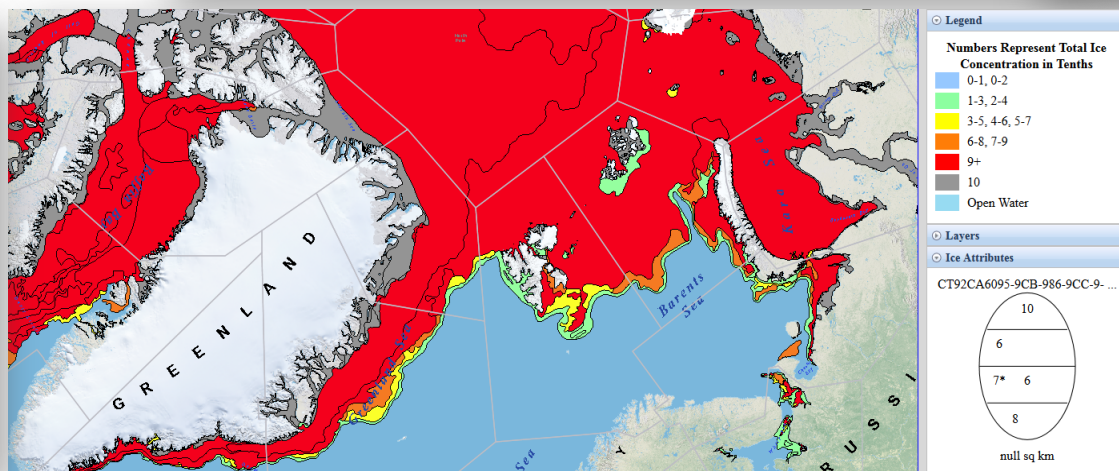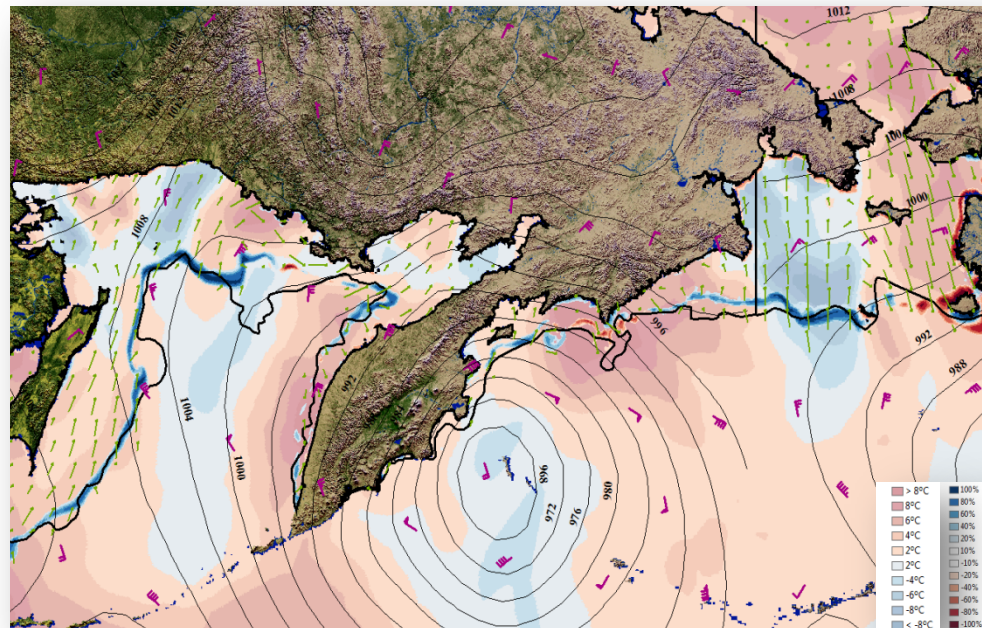
Common ACNFS Fields used for USNIC OPS

Surface Winds
Mean Sea Level Pressure
Surface Air Temperature
Sea Surface Temperature
Sea Ice Fraction
Sea Ice Thickness
Ice Drift
Lead Area Opening Rate
Sea Surface Salinity
Compressive Strength of Sea Ice
Freeze/Melt Potential
Congelation Ice Growth
Lateral Ice Melt
Top Ice Melt
Basil Ice Melt
Surface Snow Thickness
Surface Albedo Where Sea Ice
Rainfall Rate
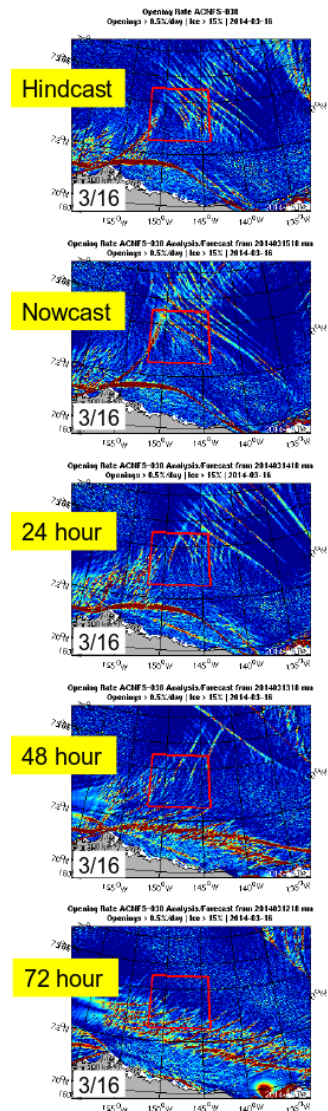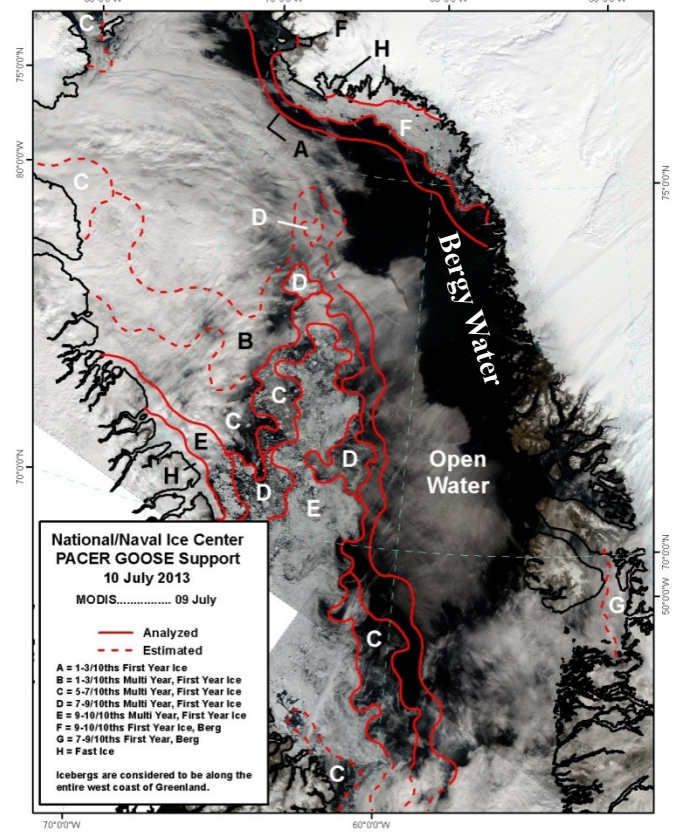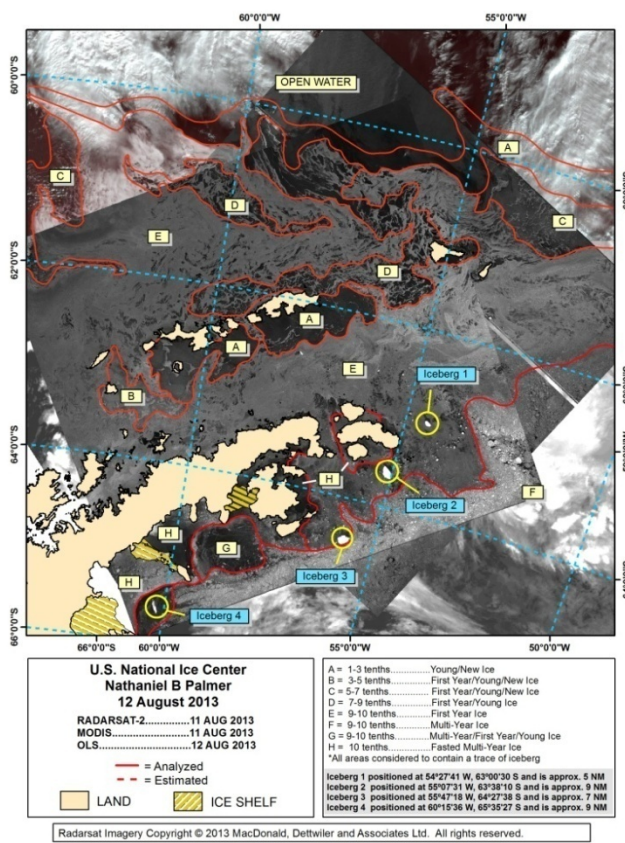Surface Temperature Where Sea Ice
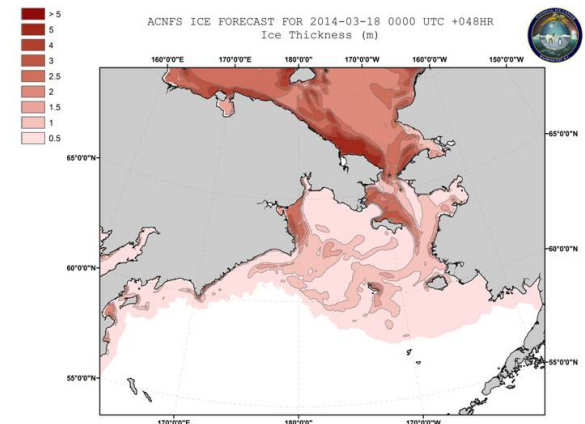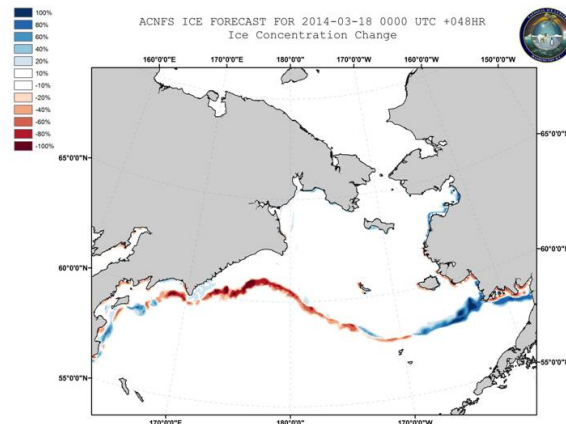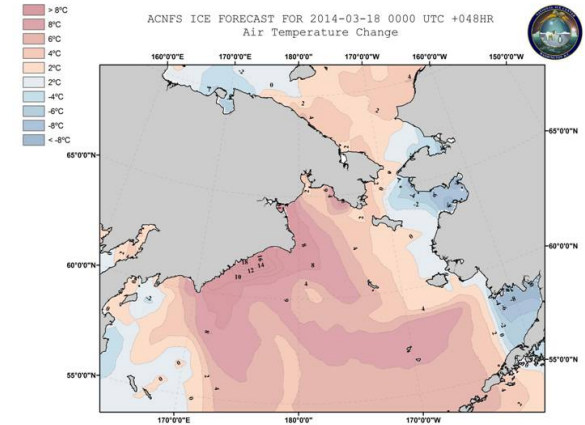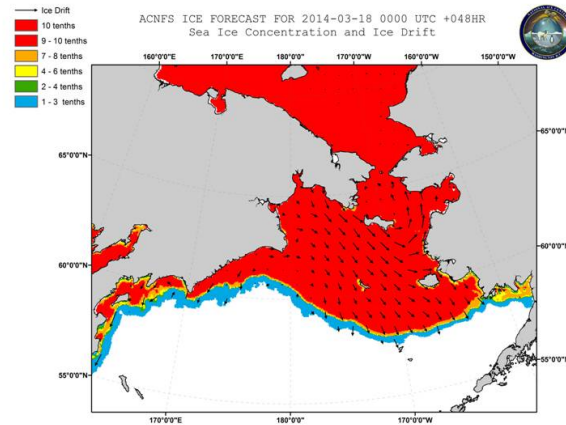
Forecasted out 7 days [t000-t168]

ACNFS for Special Support at USNIC

ACNFS forecasted fields could improve the quality and awareness of ice conditions for tailored special support

Ice Exercises

Resupply Missions

Ice Camps/Field Campaigns

"Products from NRL's Arctic Cap Nowcast/Forecast System (ACNFS)"

Fractures, Leads, and Polynyas (FLAP) Product

Provide location and orientation/directional information on fractures, leads, and polynyas across a given region
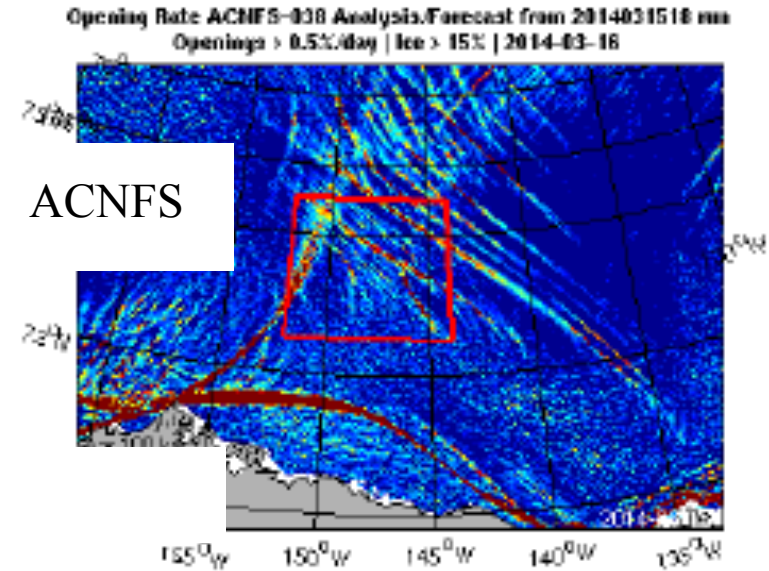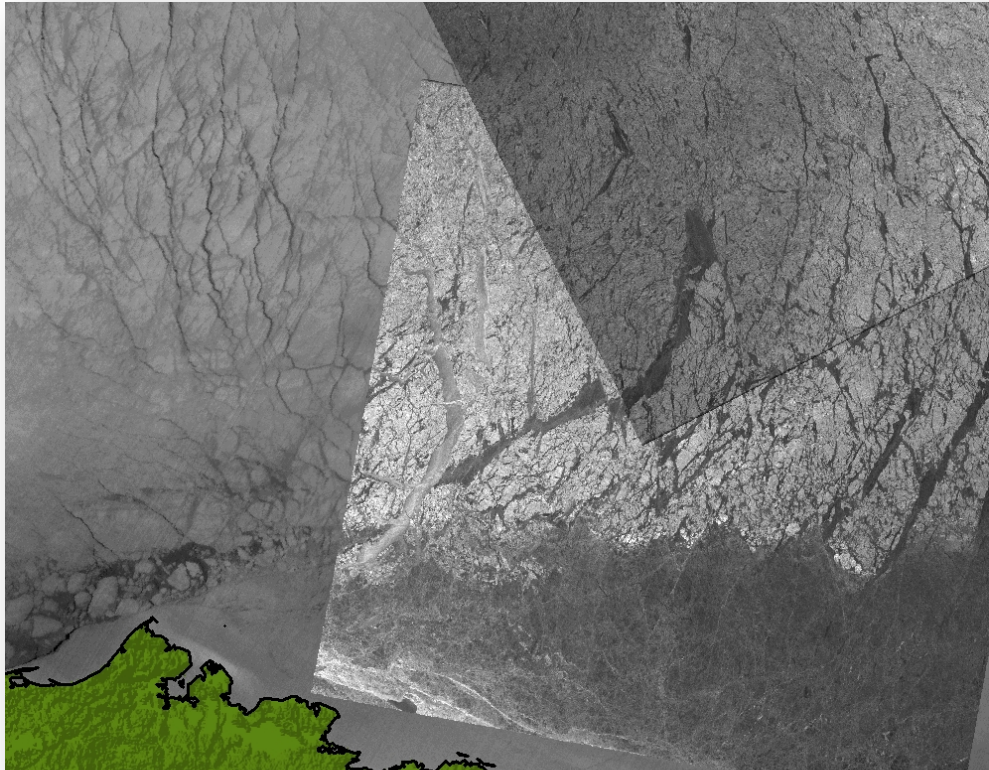

ACNFS

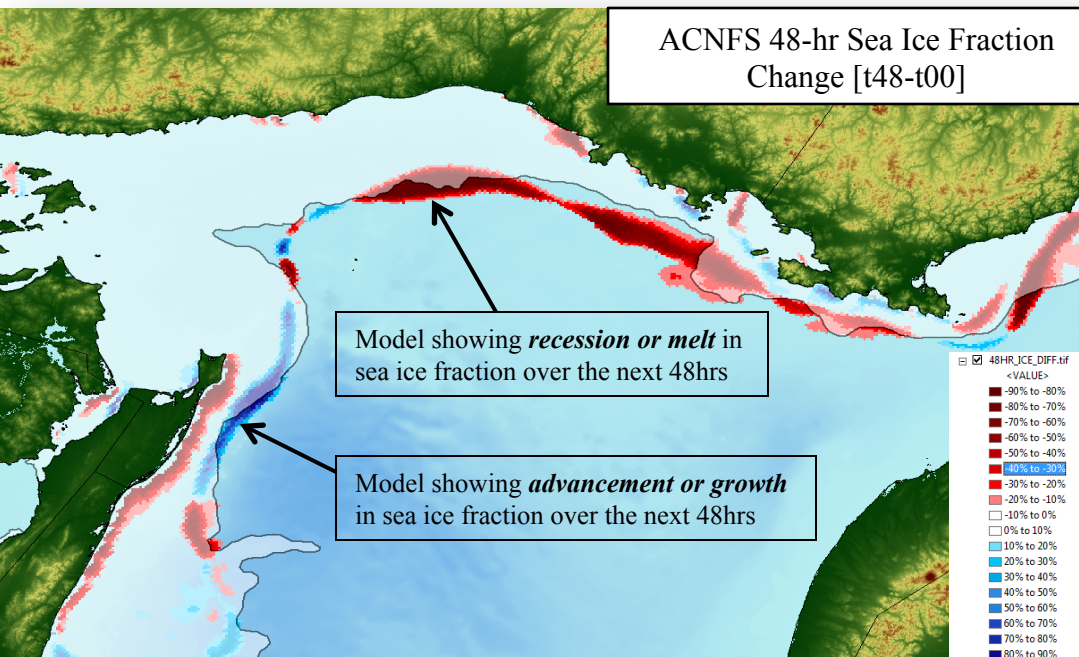Illustration from NRL's Arctic Cap Nowcast/Forecast System (ACNFS)

ICEX fracturing event with ACFNS

➢ Reversal in winds and ice drift was predicted 6 days out
➢ Large-scale fracturing was predicted 48-hrs out

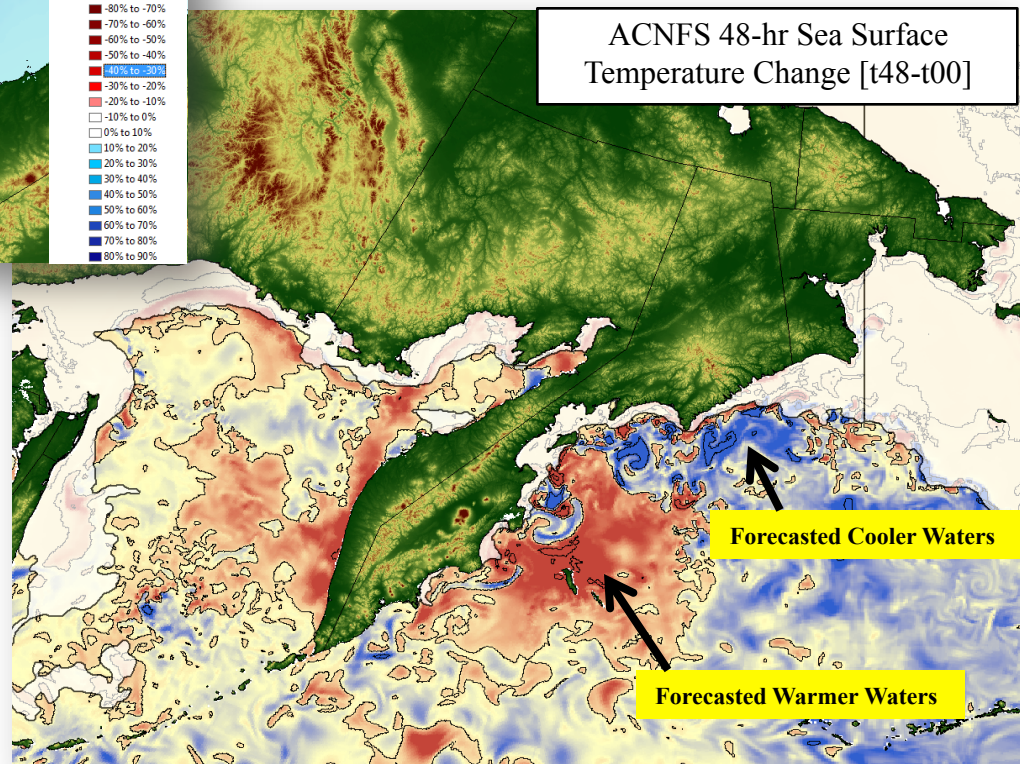Can NIC use ACNFS to provide 1-7 day FLAP Outlooks?

Use of ACNFS Difference Fields at USNIC

ACNFS 48-hr Sea Ice Fraction Change [t48-t00]

Model showing *recession or melt* in sea ice fraction over the next 48hrs

Model showing *advancement or growth* in sea ice fraction over the next 48hrs

48HR_ICE_DIFF.tif
<VALUE>
-90% to -80%
-80% to -70%
-70% to -60%
-60% to -50%
-50% to -40%
-40% to -30%
-30% to -20%
-20% to -10%
-10% to 0%
0% to 10%
10% to 20%
20% to 30%
30% to 40%
40% to 50%
50% to 60%
60% to 70%
70% to 80%
80% to 90%

Change detection from ACNFS

➢ Produce 1-7 day difference fields
➢ Difference layers more precise and uniform
➢ Can be difficult to mentally interpolate small differences
➢Less prone to interpretation errors

ACNFS 48-hr Sea Surface Temperature Change [t48-t00]

Forecasted Cooler Waters

Forecasted Warmer Waters

The analysis run (t00) ACNFS ice edge location does not match up in many cases with observed NIC ice edge well enough to use its position directly for operations, however the model still seems to accurately predict the tendencies or directional change in the sea ice between periods, making the difference fields useful.
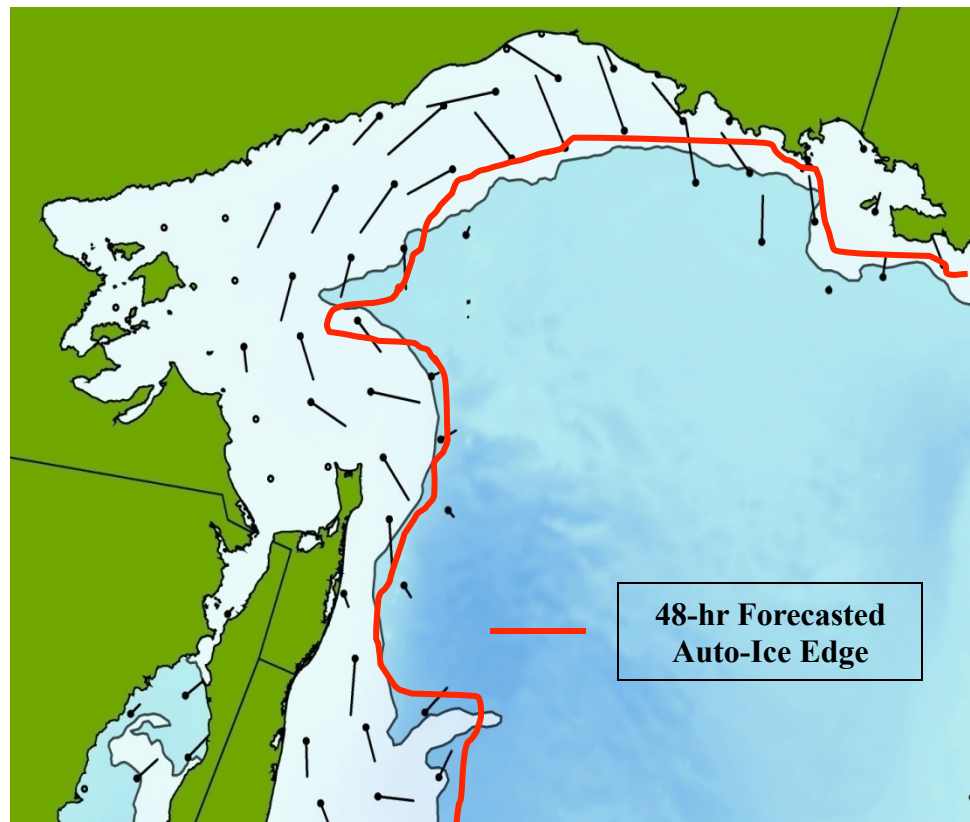
Leverage ACNFS forecasted model data for USNIC ice edge forecasting
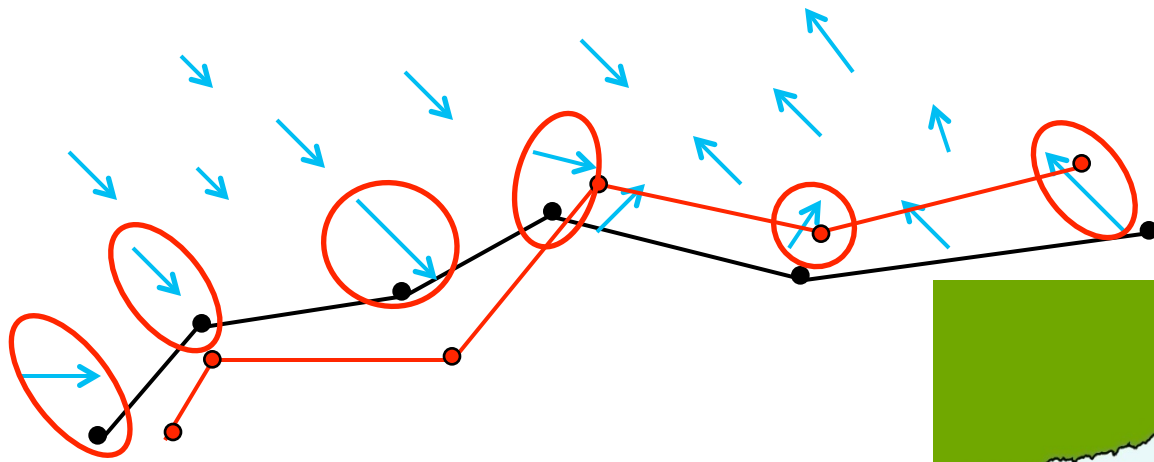
Apply ACNFS forecasted drift vectors (drift velocity and bearing) to current NIC observed ice edge

→ 48-HR DRIFT VECTOR (ACNFS MODEL)

●———● CURRENT NIC ICE EDGE (OBSERVED)

●———● 48-HR PREDICTED AUTO-ICE EDGE

48-hr Forecasted Auto-Ice Edge

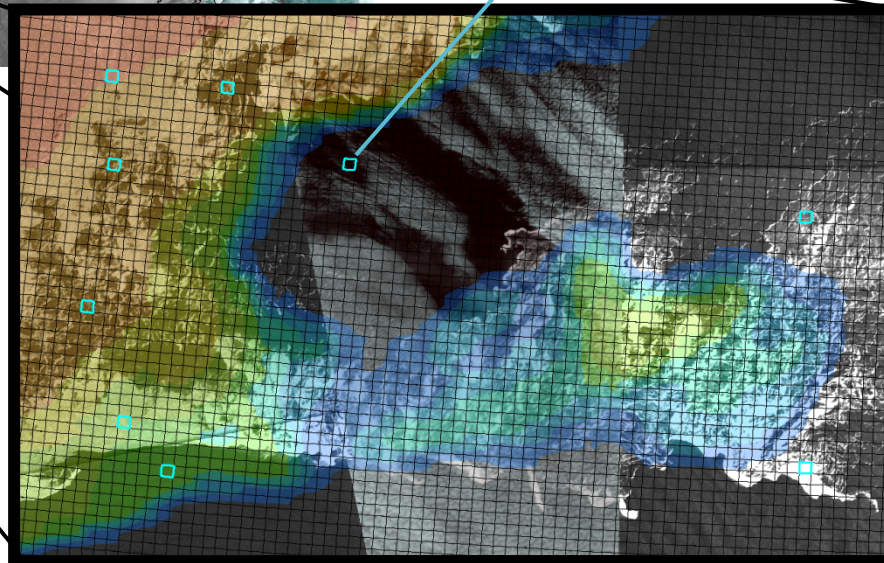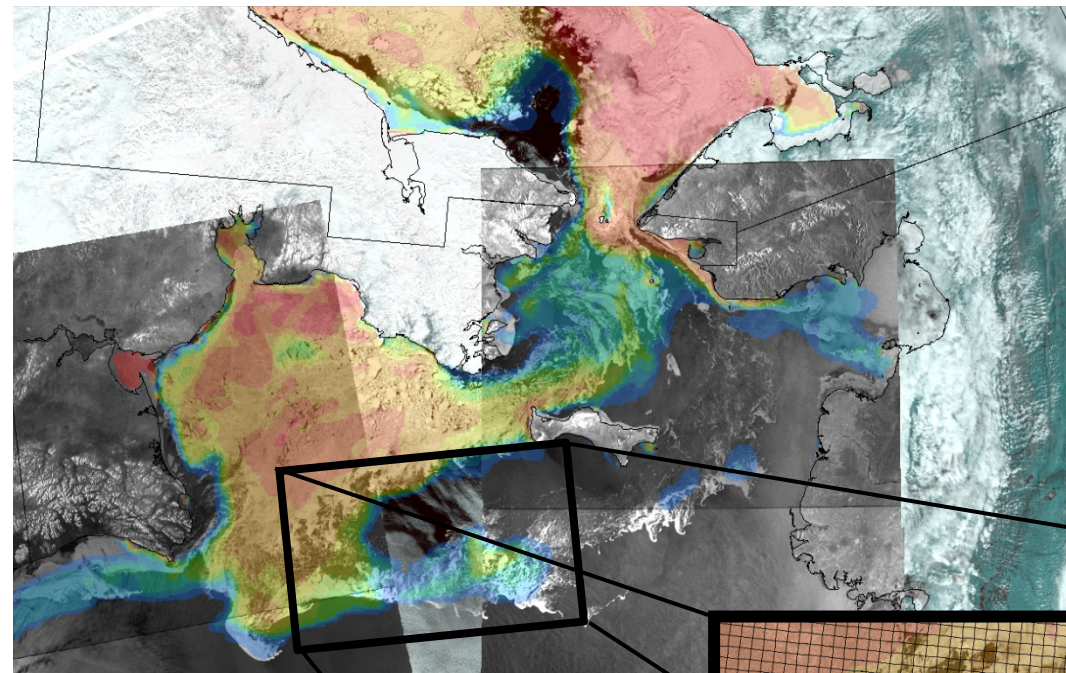*Experimental product, not currently operational*

USNIC 'Tie-Points' Project for ACNFS

Goal is to improve ice prediction model outputs by provision of precise, high quality ice condition analysis at the model cell level.

- Sea Ice Concentration
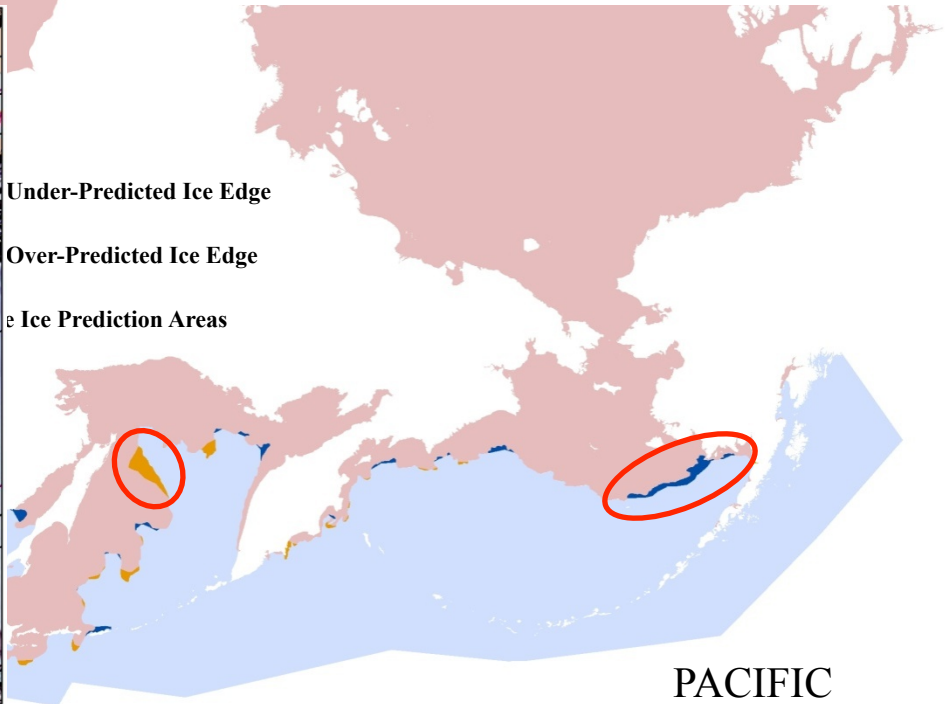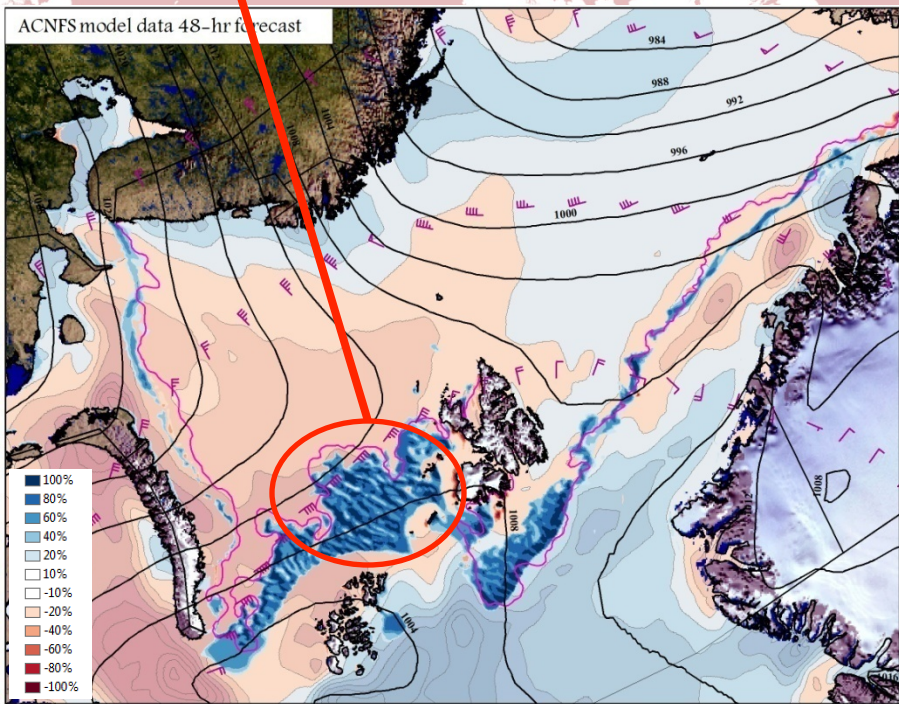- Confidence Level
- Date/Time Stamp of Image

Quality feedback into the model to assist in model refinement and in return give back more accurate modeled information for the analysts.

USNIC Ice Edge Forecast Validation Tool

ATLANTIC

> Quantitatively Assess errors in NIC's 48-hr Ice Edge Forecasts

> Compare statistics for samples using ACNFS with samples not using ACNFS

ACNFS model data 48-hr forecast

984
988
992
996
1000
1008

Under-Predicted Ice Edge

Over-Predicted Ice Edge

Ice Prediction Areas

100%
80%
60%
40%
20%
10%
-10%
-20%
-40%
-60%
-80%
-100%

PACIFIC

Summary

➢ ACNFS data fields have improved the quality and awareness of USNIC's ice analyses, support products, and forecasting capabilities

➢ Analysts are becoming familiar with the strengths, weakness, and biases of various parameters in the model and are learning where and how to apply this information

➢ Further evaluation and familiarization with individual output parameters are needed

➢ Forecast validation tool will provide further insight on the improvements in using ACNFS data for USNIC ice forecasting. Expecting results to be encouraging.

➢ GOFS version will have positive impact on USNIC Operations (includes Antarctic waters and improvements to current sea ice concentrations/fields)

➢ USNIC analysts will continue to work closely with ACNFS and NRL Oceanography Division on ways to optimize and improve ACNFS application for NAVY Operations

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Discussion