NOAA NWS Arctic Operational Forecasting Perspective

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NOAA Arctic Science Workshop

May 13, 2014

NWS Strategic Outcome:

Weather-Ready Nation Strategic Goals

Strategic Outcome: Weather-Ready Nation

- Ready
- Responsive
- Resilient

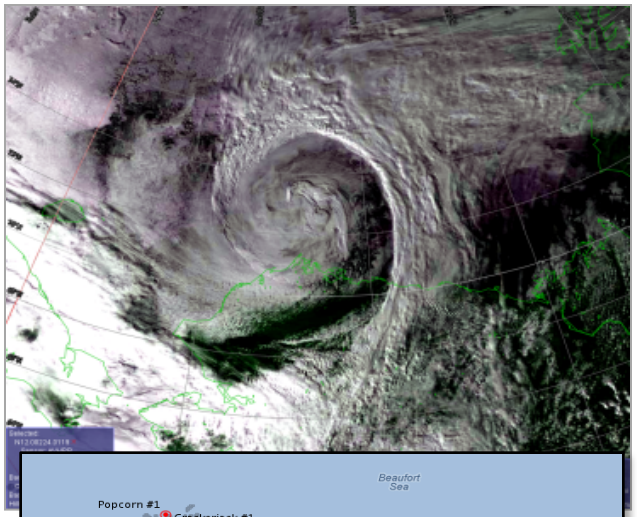
NWS Strategic Goals

- Improve Weather Decisions Services
- Improve Water Forecasting Services
- Enhance climate services and adapt to climate-related risks
- Improve sector-relevant information in support of economic productivity
- Enable environmental forecast services supporting healthy communities and ecosystems
- Sustain a highly skilled, professional workforce equipped with training, tools, and infrastructure to meet mission

Prediction is what makes us unique!

NOAA Arctic Weather and Sea Ice Service Strategy

- Improve daily to weekly sea ice models and forecasts and new seasonal prediction services
- Improve Arctic marine weather, sea ice and storm forecast services.
- Protect northern and western Alaska coastal communities from storm surge, inundation, and erosion hazards.



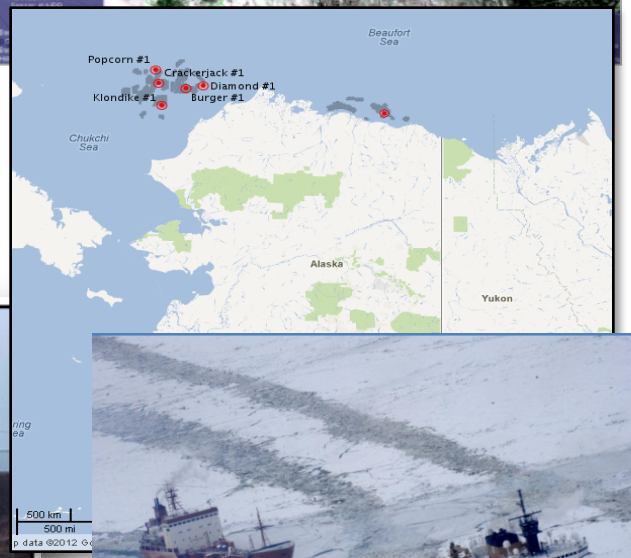


Photo 10: Shoreline erosion during coastal storm in Shismaref. (Credit: Tony Weyiouanna)

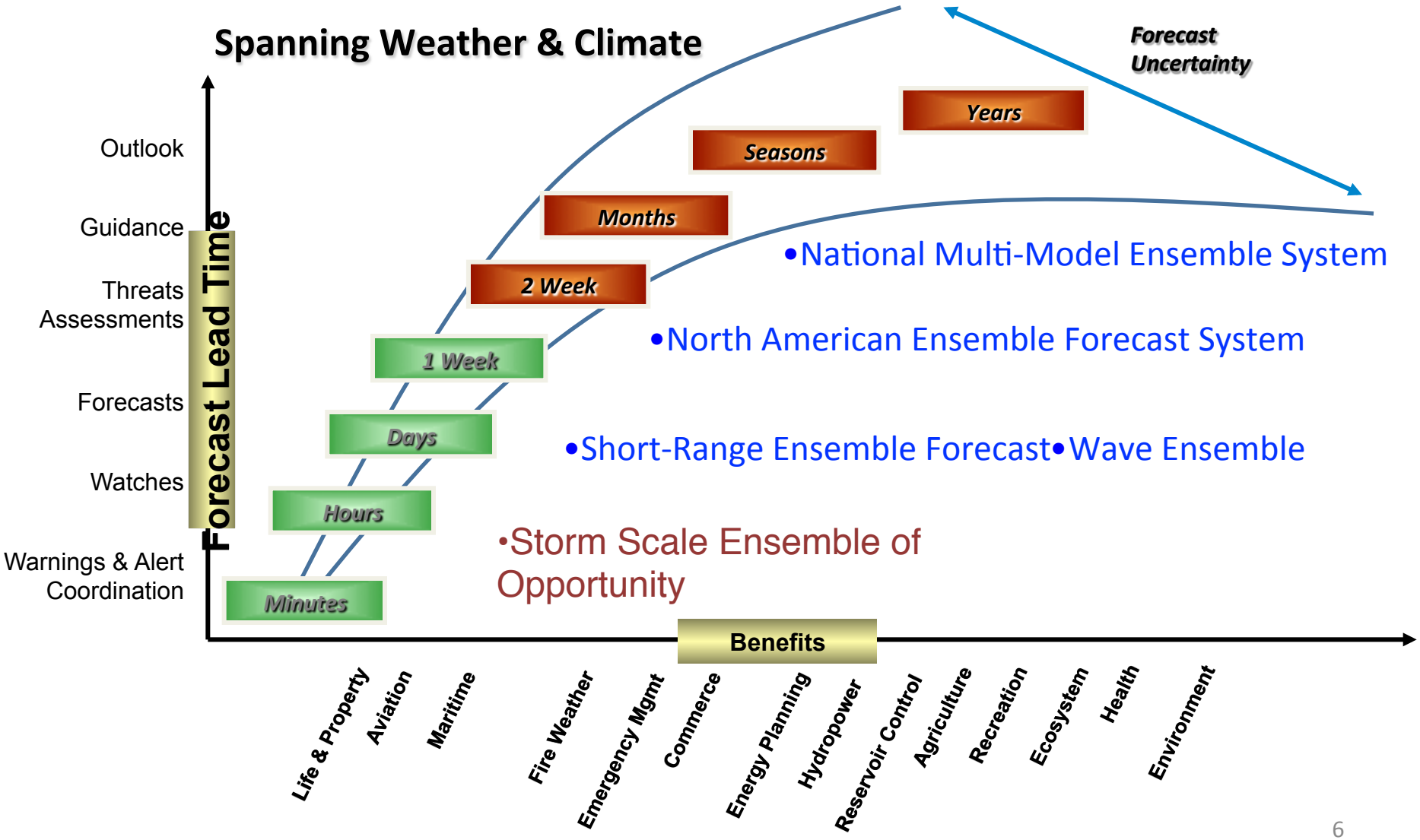
NWS Portfolio-based Management
Establishing a Fully Integrated Field Structure

Existing ORF Programs	*Proposed PPAs*
Surface, Ocean & Upper Air Observations, Aircraft Obs, Radiosondes, NEXRAD, ASOS, Buoys, Snow Surveys, Profilers, National Mesonet, Observations Support	Observations
Data Collection/Display, AWIPS, Model Implementations, Supercomputing, Advanced Hydrologic Prediction System	Central Processing
WFO Forecasts & Warnings, National Service Centers, River Forecast Centers, CWSUs, Tsunami Services, Decision Support Services, WCM Program	Analyze, Forecast, & Support
IT & Dissemination Systems; Telecommunications Gateway, NOAA Weather Radio; NEXTGEN, Ground Readiness, NOMADS	Dissemination
Research/Development/Assess, Environmental Modeling Center, Test and Demonstration, WRN Pilots, Operational Proving Ground, Testbeds, Training, CSTAR, Education & Outreach, SOO Program	Science & Technology Integration

STI: Initial FY 2015 Milestones

Transition/ Enhance Models	Coordinate, Facilitate and Manage Field-Driven R2O	Support National Service Programs	High Visibility NOAA Priorities	STI- Program Training
Next Generation Global Prediction System (NGGPS): - ***NEMS ready for operational coupled system*** - ***Coupled atmosphere, ocean, wave, sea ice models***	A Centralized Development/Testing Environment: - Demonstration on coordinated development using VLab/OPG environment - Major VLab improvement objectives (e.g., moving VLab infra. to IDP-CP/B) National SOO Conference	Hydro/Water: - Centralized water forecast demonstration - Science & S/W modernization for coherent NWC, RFC and WFO hydrologic operations	***Arctic:*** - ***Implement enhanced experimental sea ice forecasts for Alaskan Arctic*** - ***Issue experimental Arctic Sea Ice melting/freezing outlook***	Satellite Apps: - Develop Himawari-8 training for PR/AR
Major Operational Model Upgrades: - HWRF - NAM - GDAS/GFS - Regional Ensembles - RTMA/URMA upgrade	WRN/IDSS: (*) - Complete the IDSS Metrics development - Complete beta test version of Impact Catalogue; deploy for OT&E	Aviation : (*) - Experimental probabilistic guidance grids enabling local-national consistency - Aligning processes and technical capabilities at Aviation centers	***Enabling Environmental Forecasting:*** - ***Demonstrate capability to ingest new datasets into AWIPS-2 for E.F.***	WRN/IDSS: - Develop Impact Catalog Training - Develop HRRR training
Developmental Systems: - GEFS - CFS v3 - NCODA transition	Testbeds: - Coordinated Testbed experiments to support field R2O	Severe Weather: (*) - Begin implementing WoF/ FACETs		Hydro/Water: - Develop Hydro training
Risk: Developmental Computing Capacity	The National Blender: - Prototype blender ready to support IOC	Space Wx: - NEMS-WAM: prototype 2-day ionosphere forecasts - Geospace model transition		
	OPG - Integration/testing of GOES-R products in WFO forecasting process	Tropical/Marine: - P-surge for tropical and extratropical	(*) – Social Science component	

Transition/Enhance Models
NOAA's Suite of Operational Ensemble Models



Transition/Enhance Operational Models

- Short Term Objective:
  - Coupled Operational Ensemble NWP System
  - NWP timescale: 0-16 days extending to 30 days
  - Operational Arctic Sea Ice prediction capability
- Schedule:
  - Using existing operational component models
  - Coupling in NEMS (FY15)
  - IOC: FY16
- Long Term Objective:
  - Next generation operational global prediction system (NGGPS)
  - Partnership with OAR and the research community
  - A comprehensive plan under development (FY14 deliverable)

Next Generation Global Prediction System (NGGPS)
Research to Operations Initiative (R2O)

Project Status as of: 1 May, 2014

Project Information and Highlights

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Lead:
Fred Toepfer & Steve Lord Project Managers

Scope: Build NGGPS - Coupled NWP to 30 daysfor – for Improved Model Guidance;

1) Expand and accelerate critical weather forecasting research to operations (R2O)
2) Accelerate development and implementation of improved global weather prediction models
3) Improve data assimilation techniques
4) Improve software architecture and system engineering
5) Promote hurricane forecast models that meet societal requirements

Estimated Benefits:

1) Address growing service demands
2) Increase d accuracy and lead time for high impact weather forecasts
3) More reliable probabilistic forecasts
4) Effectively mitigate economic disruption from hurricanes and other predictable weather phenomena

Scheduling

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Milestone	Date	Status
Initiate Effort: Charter approved	02/13/2014	Complete
Planning Teams Organized	03/31/2014	Complete
Develop Spend plan for 2014 Appropriation	04/30/2014	Begun
Begin Coupled System Development using NEMS	04/01/2014	Begun
Initiate Joint Physics/Land Projects with CPO	08/15/2014	Funding Decision made
NGGPS Implementation Plan Complete	9/30/2014	Begun
Award External Grants	3/30/2015	AO Begun
NEMS Physics Interoperability Interface Implemented	9/30/2015	Begun
Demonstrate Coupled NWP System	9/30/2015	Not Begun

Issues/Risks

Y

Risks & Issues:

1. Obligating R2O funds subordinate to obligating Sandy Sup. funds
2. Increased WCOSS Developmental Computing Capacity Needed
3. Coordination with/completion of effort started under Sandy Supplemental Appropriation

Mitigation

1. May need to carryover some funds
2. Working with NCO to identify WCOSS funds that can be used to increase Developmental Computing Capacity
3. Close coordination with HIWPP and Gap Mitigation Effort

Finances

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Funding Sources:
ORF $7,797,934

Obligation Status
$500,000 transferred to OAR/CPO Joint Support for Grants

Execution Status

R	Management Attention Required	Y	Potential Management Attention Needed	G	On Target

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Future Service Paradigm

Modeling	Forecaster	User
A unified system with earth system components (Oceans, Ecosystems, Cryosphere)	Higher-order decision making with greater emphasis on communicating uncertainty and impact	Decisions informed by NOAA's probabilistic environmental intelligence

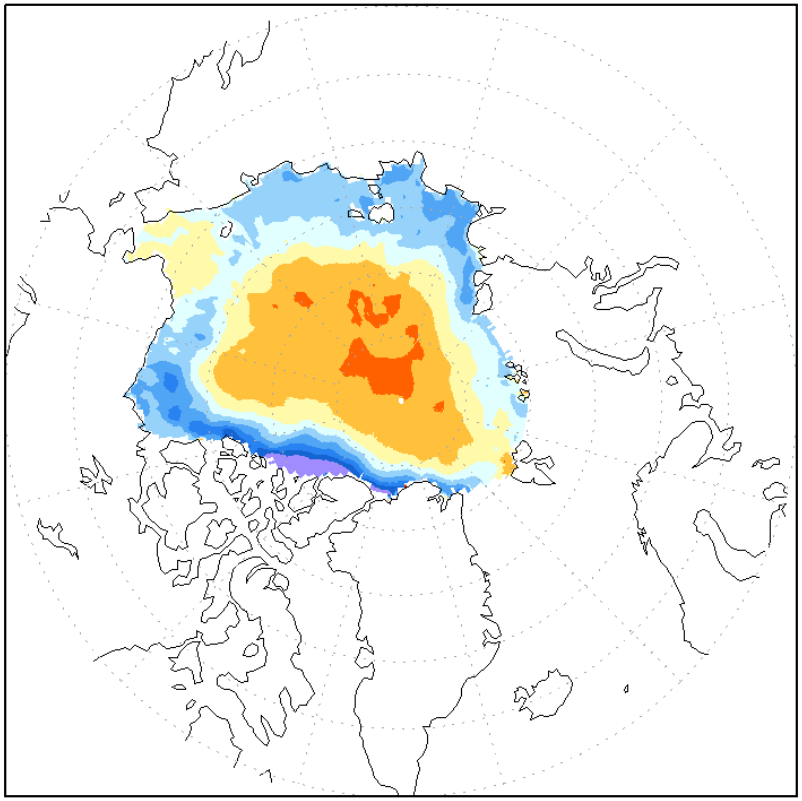
NOAA Priority: Arctic

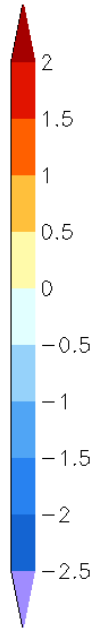
- Enhance Alaska Sea Ice Services
- Improve CFS.v2 Arctic Sea Ice Prediction
  - Improve model physics to reduce model bias
  - Improve initialization for sea ice thickness
- Schedule
  - Extending AR Sea Ice services from 5 to 7 days/week (Q3FY14)
  - CFS bias and initialization improvements (Q4FY14)
  - Issue experimental melting outlook for 2015 season (Q2FY15)
  - Issue experimental freezing outlook for 2015 season (Q3FY15)

Initial sea ice thickness contains systematic bias

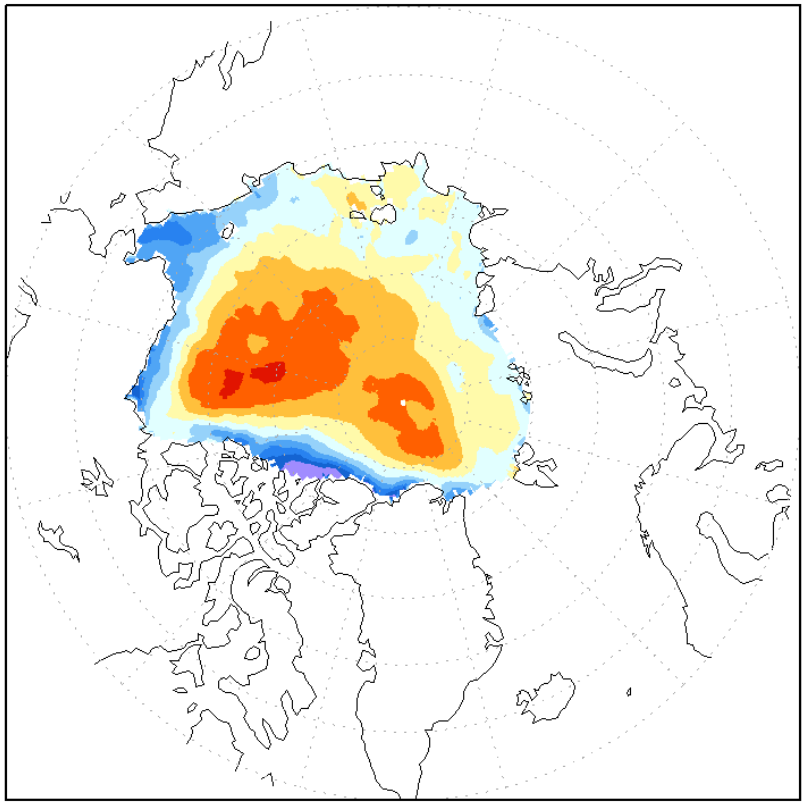
CFSR minus ICESat (2003-2008 average)

October – November





Februarv – March



- Too thin near the coasts
- Too thick Over the central Arctic

Improving Arctic Sea Ice Prediction Services

Project Information and Highlights

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Lead: Joseph Sienkiewicz
NCEP (CPC, OPC, EMC, NCO), AR

Scope:

1) Develop seasonal outlooks for Arctic Sea Ice melting and freezing time
   - Use Pan Arctic Ice Ocean Modeling and Assimilation (PIOMAS) sea ice analysis to initialize sea ice in CFS v2
   - Provide experimental seasonal outlook for melting/freezing time for 2015 season
2) Enhance short range (1-3 days) Alaska Region sea ice forecast services
   - Incorporation realtime Evaluation Environment Canada and U.S. Navy operational sea ice forecast model guidance into NWS operational data flow and AWIPS-2
   - Incorporate model guidance to enhance AR operational sea ice forecast products and DSS services

Estimated Benefits:

1) Seasonal sea ice outlook for melting/freezing time to support marine transportation/recreation planning, and support BOEM for management for Arctic oil/gas exploration activities;
2) Enhanced DSS services to a broad Alaska coastal and marine users

Scheduling

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Milestone	Date	Status
Establish Navy Arctic Cap model data to NCEP (NCO)		complete
Establish data flow for EC RIPS model data to NCEP (NCO)		Complete
Begin sea ice initialization development using PIOMAS (CPC)	Q3	
Incorporate Navy model guidance into AWIPS-2/NCP (OPC)		On Track
Incorporate Canadian model guidance into AWIPS-2/NCP (OPC)		On Track
Extending AR sea ice service from 5 to 7 days/week	**Q3**	**On Track**
Complete the sea ice initialization development (CPC)	Q4	
Experimental/operational enhanced sea ice forecasts (AR)	Q1FY15	
Complete hindcasts (CPC)	Q1FY15	
Issue experimental melting outlook for 2015 season (AR, CPC)	**Q2FY15**	
Issue experimental freezing outlook for 2015 season (AR, CPC)	**Q3FY15**	
WaveWatch III domain expanded to the entire Arctic Ocean	Q4FY15	
Coupled operational atmosphere-ocean-wave-sea ice NWP model demonstrated	**Q4FY15**	

Issues/Risks

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Issues:

1) Need R&D HPC resource. NOAA R&D HPC resource is over subscribed

Mitigation:

Finances

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Funding Sources:

1) LWF/STI for CPC: $150K (FY14, Fy15)
2) LWF for NCO/EMC: $50K (FY14)
3) LWF/STI for OPC: $50K (FY14, FY15)
4) LWF/STI for AR: $200K (FY14, FY15)
5) STI for EMC: Base FTE and contract support + NGGPS development funds

Status:

R Management Attention quired	Y Potential Management ention Needed	G On rget

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NOAA Priority:
Environmental Forecasting

- Ingest new observing datasets into AWIPS-2 (FY14-15)
  - VIIRS imagery **(Wx and Sea Ice)**
    - Include visible, infrared and day/night band
    - Important for sea ice analysis/forecasting
  - Altimeter wind speed/wave height **(Marine)**
  - Operational Sea Ice forecast model guidance (U.S. Navy, Environment Canada)
  - Ocean Color data (*Enabling Ecological Forecasting*)

Summary

- Arctic is a National priority
- Increasing demand for NWS services in Alaska/Arctic
- NWS is taking actions (existing resource) to deliver outcomes:
  - Short term outcomes:
    - Enhanced Alaska/Arctic Wx and Ice service delivery
  - Long term outcomes:
    - Enhancing modeling, forecasting and service delivery infrastructure to meet future demands

- Backup

NWS Alaska/Arctic Services

Sea Ice and the Alaska Fishing Industry

Freezing Spray, accumulated beyond the ice edge

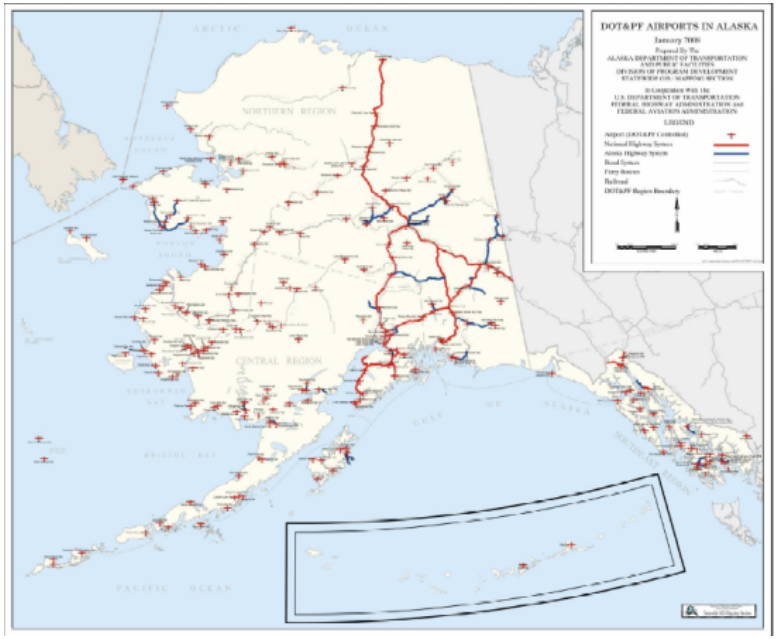
Fishing for Ophelia Crab in the Bering Sea

The combined value of Alaska seafood exports and the retail value of Alaska seafood sold in the U.S. totaled an estimated $6.4 billion. The Alaska seafood industry directly employed 63,100 workers in Alaska, making it the state's largest private sector employer. Total direct and secondary economic output in the U.S. stemming from the Alaska seafood industry was estimated at $15.7 billion.

NWS Alaska/Arctic Services

Resupply and Supply Chain Management

USCG Healy escorted Tanker Renda to resupply Nome, AK and surrounding villages with fuel for the winter. (Dec 2011 – Jan 2012) through over 400 miles of Bering Sea ice

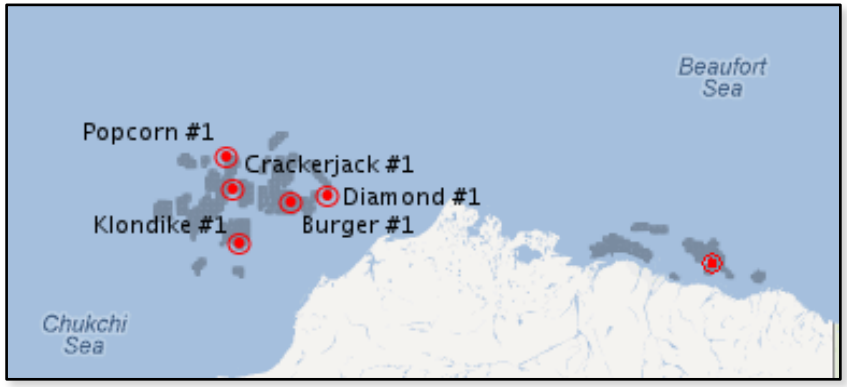


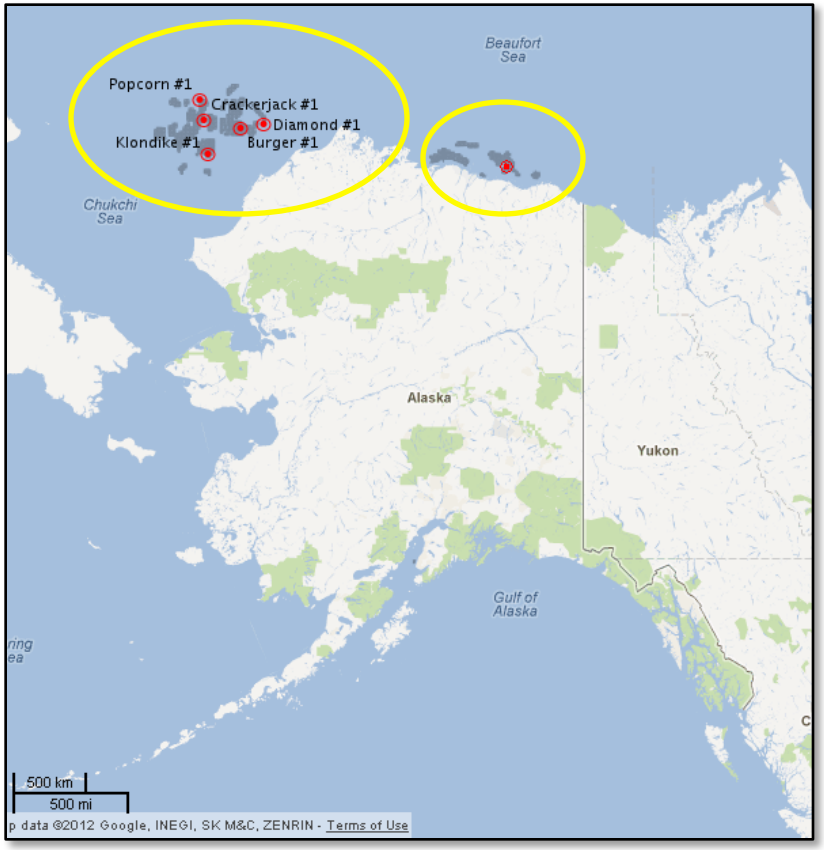
Fuel and food for rural Alaska

NWS Alaska/Arctic Services

Decision Support in the Arctic

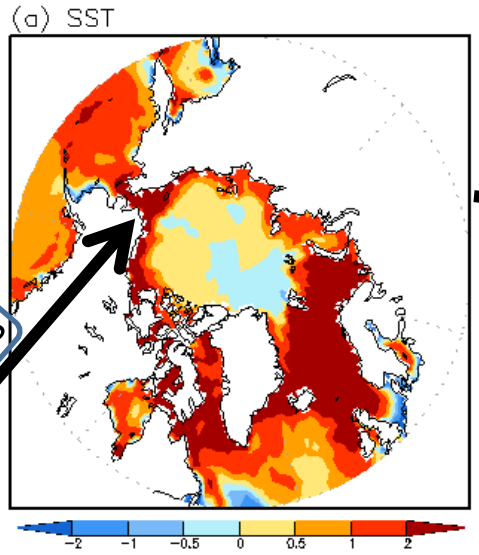
- In Early September 2012, Department of Interior (DOI)/Bureau of Energy Management (BOEM) requested NOAA support:
  - To provide our best forecast for freeze-up at the Burger drill site
  - To provide weekly updates to the initial ice forecast and weather conditions of significance to operations





Cloud-radiation errors result in sea ice bias

Jul-Nov Model bias

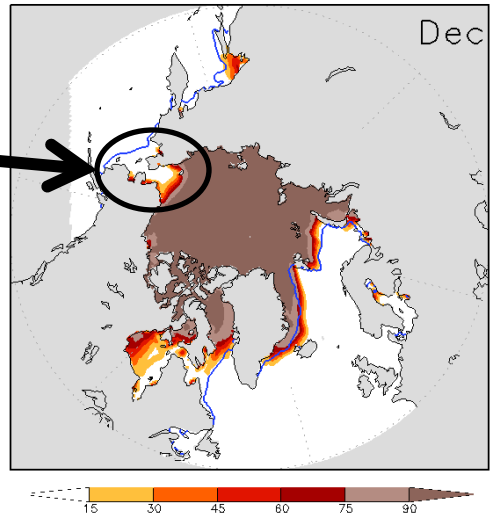


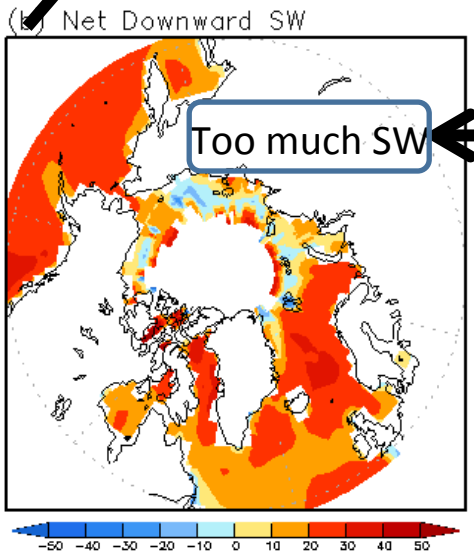
Too warm SSTs

Delayed sea ice formation

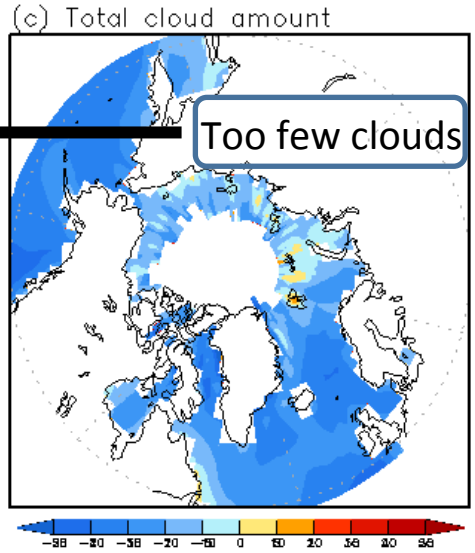
December sea ice concentration

Shading: CFSv2; Contour: NCDC 15%





Too much SW



Too few clouds

- CFSv2 SSTs are too warm resulting in a delayed sea ice formation
- The warm SSTs are due to excessive downward surface solar radiation which is related to negative bias in cloud amount

NGGPS
Coupled Sea Ice Prediction Model

- Challenges
  - Predictability dominated by surface flux errors.
  - CICE in Arctic Cap model does not beat persistence for short time forecast
- Approach:
  - Coupled atmosphere-ice-ocean.
  - Ensemble approach
- Year-1:
  - Deterministic coupled model
  - Develop metrics for ice prediction
- Year-2
  - Expand to ensemble system, (year 2).
  - Focus on 2 or 4 week forecast
- Beyond
  - Full operational implementation
  - Extending timescale toward seasonal prediction