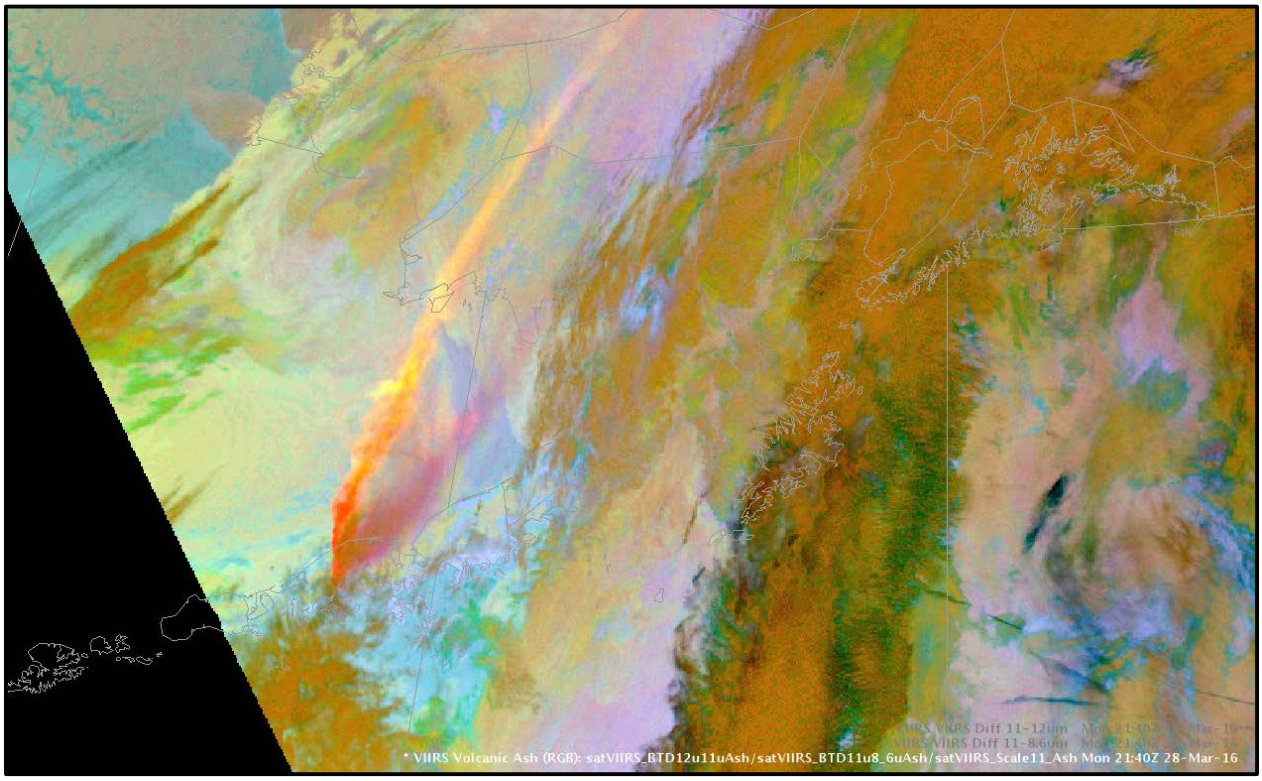
Cooperative Institute For Alaska Research

Fourth Report to NOAA on Cooperative Agreement NA13OAR4320056

1 April 2016 - 31 March 2017



UNIVERSITY OF ALASKA FAIRBANKS

Fourth report from the Cooperative Institute for Alaska Research (CIFAR) to NOAA, regarding Cooperative Agreement *NA13OAR4320056*

1 April 2016-31 March 2017

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Cover graphic is credited to UAF-GINA. Multispectral color composite showing airborne ash from Pavlof Volcano on the Alaska Peninsula on March 28, 2016. The image satellite data was captured at UAF-GINA from the NOAA NESDIS Suomi NPP VIIRS sensor. It is being displayed in the software used by NOAA NWS forecasters (AWIPS). Data was delivered from UAF-GINA to the NWS less than 15 minutes after satellite overpass and combined into this image which highlights the volcanic ash–a major hazard to aircraft.

CIFAR annual reports can be found on the Web at http://www.cifar.uaf.edu/research/reports.php.

Overview

Founded in 2008, the Cooperative Institute for Alaska Research (CIFAR) conducts ecosystem and environmental research related to Alaska and its associated Arctic regions, including the Gulf of Alaska, Bering Sea, Chukchi/Beaufort Seas, and Arctic Ocean. CIFAR continues to facilitate the well-developed long-term collaboration between NOAA and the University of Alaska (UA) begun under the Cooperative Institute for Arctic Research in 1994, within which targeted research, technology, education and outreach can be developed and sustained. CIFAR plays a central role in communication and coordination between NOAA, researchers, management agencies, non-governmental organizations, Alaska communities, and the general public in collaborative research, education, and outreach efforts.

Vision, Mission, and Research Themes for CIFAR

The ***CIFAR Vision*** *is*:
Understand the Alaska environment for the protection of society.

The ***CIFAR Mission*** *is*:
Fostering collaboration between NOAA, the University of Alaska, and others doing research in Alaska and its associated Arctic regions.

The ***CIFAR Research Themes*** are:

1) Ecosystem studies and forecasting—Gain sufficient knowledge of Alaskan ecosystems to forecast their response to both natural and anthropogenic change.
2) Coastal hazards—Improve understanding of coastal hazards, storms, and tsunamis that affect Alaska's population, ecosystems and coast to improve weather forecast and warning accuracy.
3) Climate change and variability—Foster climate research targeted at societal needs and advance Arctic climate research to improve predictive capacity of climate variations affecting coastal regions and ecosystems.

CIFAR's research activities assist NOAA in four of its Mission Goals: (1) Healthy oceans: Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management; (2) Climate adaptation & mitigation: Understand climate variability and change to enhance society's ability to plan and respond; (3) Weather ready nation: Serve society's needs for weather and water information; and (4) Resilient coastal communities & economies: Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation.

Membership of CIFAR's Advisory Groups

Listed below are the members of the CIFAR Executive Board and CIFAR Fellows who are responsible for advising CIFAR. The Executive Board and Fellows did not meet in FY17.

The ***CIFAR Executive Board*** members are:

1. Christopher Sabine, NOAA Office of Oceanic & Atmospheric Research (OAR) Pacific Marine Environmental Laboratory (PMEL) Director
2. Jeremy Mathis, NOAA OAR Arctic Research Office Program Manager
3. Douglas DeMaster, NOAA National Marine Fisheries Service (NMFS), Director, Alaska Fisheries Science Center (AFSC)
4. Carven Scott, Director NWS Alaska Region
5. Robert McCoy, Director of Geophysical Institute, University of Alaska Fairbanks
6. Bradley Moran, Dean of the College of Fisheries and Ocean Sciences (CFOS), University of Alaska Fairbanks
7. James Partain, NOAA Regional Climate Services Director, Alaska Region
8. Uma Bhatt, CIFAR director, ex officio

The ***CIFAR Fellows*** are:

1. Larry Hinzman, Vice Chancellor for Research, University of Alaska Fairbanks (UAF), Fairbanks, AK
2. Kris Holderied, Director NOAA/NOS Kasitsna Bay Laboratory, Homer, AK
3. Anne Hollowed, AFSC, NMFS, NOAA, Seattle, WA
4. Henry Huntington, Huntington Consulting, Eagle River, AK
5. Katrin Iken, Professor of Marine Biology, Institute of Marine Science (IMS), CFOS, UAF, Fairbanks, AK
6. Seth Danielson, Research Associate Professor of Physical Oceanography, CFOS, UAF, Fairbanks, AK
7. Gordon Kruse, President's Professor of Fisheries, SFOS, UAF, Juneau, AK
8. Betsy Baker, Executive Director, North Pacific Research Board, Anchorage, AK
9. Molly McCammon, Director, Alaska Ocean Observing System, Anchorage, AK
10. Phil Mundy, Division director, Auke Bay Laboratory, AFSC, NMFS, NOAA, Juneau, AK
11. James Overland, Oceanographer, PMEL, NOAA, Seattle, WA

Summary of Awards Made during Reporting Period

During the third reporting year of our renewal cooperative agreement NA13OAR4320056, NOAA provided 16* amendments to the CIFAR renewal agreement for CIFAR core administration, one Task I education and outreach amendment, two Task II and 12 Task III research awards totaling over $1.7M. A full list of CIFAR awards made during the reporting period is presented in Appendix 1.

Summaries of CIFAR awards funded this reporting period by task/ theme are shown in Table 1. Table 2 shows the distribution of CIFAR Task I, II, & III projects (percentage of total) by NOAA line office.

Table 1: Summary of CIFAR Awards Funded 1 April 2016-31 March 2017: by Task and Theme

Theme	Number of Awards	Total Amount	Subtotals by Task	Percent of Total (rounded)
Administration (Task I)	**17***		**$234,144**	**13.60%**
Core Support	16*	$148,822		
Education & Outreach	1	$85,322		
Research Themes (Task II & III)	**14***		**$1,492,012**	**86.40%**
Climate Change & Variability	6	$938,039		54.30%
Coastal Hazards	1	$240,000		13.90%
Ecosystem Studies & Forecasting	7	$313,973		18.20%
Total	**17***		**$1,726,156**	**100.00%**

Table 2: Summary of CIFAR Task I, II & III Awards Made 1 April 2016-31 March 2017: by Funding Source

Funding Source	Number of Awards	Total Project Amount	Percent of Total	Total Task 1 Amount	% of Task I Recovery paid
NESDIS	4	$786,113	49.84%	$68,581	46.08%
OAR	4	$244,987	15.53%	$31,627	21.25%
NWS	1	$240,000	15.22%	$21,360	14.35%
NMFS	5	$220,912	14.01%	$19,660	13.21%
NOS	1	$85,322	5.41%	$7,594	5.10%
Total	**15**	**$1,577,334**	**100.00%**	**$148,822**	**100.00%**

**CIFAR received a total of 17 amendments during this reporting period. Of the 17 amendments, 13 included award amounts for Task II/III project and Task 1 recovery amounts, one was only for a Task III project amount, one was for a Task I (E&O) project and Task I recovery amounts, and two were only for Task I recovery amounts.*

During the current reporting year, the funding of Task I core administration support for CIFAR was billed to line offices based upon the NOAA's implementation of the Task 1 recovery 'pay as you go' policy. CIFAR's Task 1 recovery fee was 8.9% for part of this reporting period, and is now 8.5%.

Highlights from CIFAR Task I Activities

Core Administration

The primary role of CIFAR administration is to support research, education, and outreach carried out under the auspices of the Cooperative Institute. CIFAR is currently staffed by four UAF employees, who all but three, also staff various other departments: Uma Bhatt, director, working on a 1.0 FTE; Nancy Fresco, associate director, working on a 0.75 FTE; Sarah Garcia, CIFAR administrator, working remotely on a 0.625 FTE; and Nate Bauer, publications manager, working on a 1.0 FTE. During this reporting period, the CIFAR staff dedicated work load was:

1) Uma Bhatt, CIFAR director, 25.00% FTE (Task 1 and match)
2) Nancy Fresco, CIFAR associate director, 18.75% FTE (match)
3) Sarah Garcia, CIFAR administrator, 62.5% FTE (Task I and match)
4) Nate Bauer, publications manager, 3.84$ FTE (match)

Uma Bhatt provides overall CIFAR programmatic guidance and oversees daily operations. She is responsible for approving all CIFAR proposals and overseeing reporting obligations. Nancy Fresco provides support for CIFAR activities and scientific content to the CIFAR web page.

Education and Outreach

All four of the NOAA mission goals require highly trained scientists and managers, and many retirements from the U.S. labor force are impending over the next decade. Also, the NOAA human resource needs include research scientists with an interdisciplinary training in the physical, environmental, and social sciences. Thus, CIFAR continues to emphasize competitively supporting graduate and undergraduate students (in addition to those supported on CIFAR research projects) whose research addresses issues critical to both NOAA and the Alaska region. Because CIFAR is positioned within the University of Alaska system, we link faculty and students from various departments and campuses to collaborate with NOAA scientists on research and educational efforts. Names of students involved in CIFAR research and education projects are shown in bold face in the summary below.

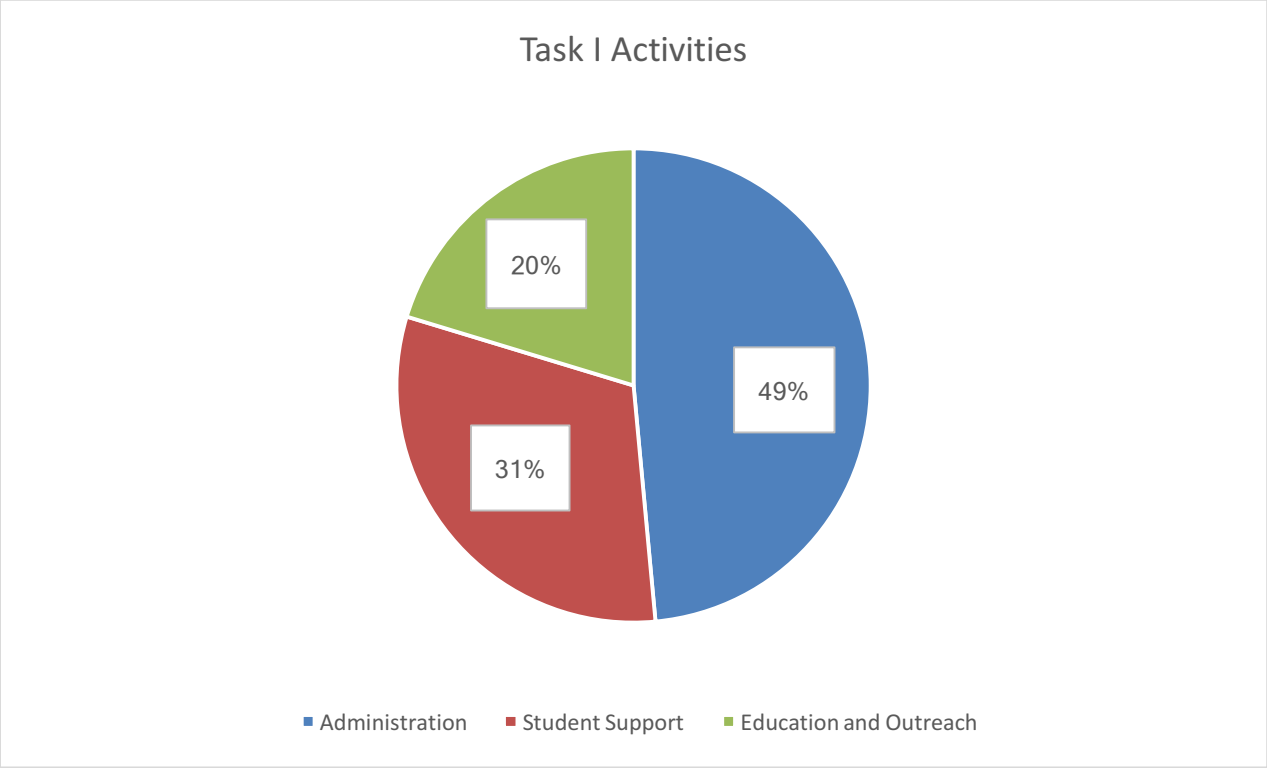
A proposal review panel met on 1 April 2016 and recommended full or partial funding of 16 projects for awards running from 1 July 2016 to 30 June 2017. Twelve of these awards were funded with CIFAR match or Task 1 education funds.

The students and their FY17 CIFAR projects are listed here:

1. **Matthew Whitley**, College of Natural Science and Mathematics, UAF
   "Thermokarst-induced landscape change on the Yukon Kuskokwim (YK) Delta, Alaska, USA."
2. **Taylor Gofstein**, Institute of Arctic Biology, UAF
   "Fate and Effects of Petroleum Contamination and Chemical Dispersants in Arctic Marine Environments."
3. **Richard Buzard**, College of Natural Science and Mathematics, UAF
   "Coastal communities threatened by climate change: Coastal hazard assessment through citizen scientists monitoring programs in southwest Alaska."
4. **Stephanie Crawford**, Institute of Arctic Biology, UAF
   "Sea lions as sentinels of ecosystem health: Using fasting profiles of nursing Stellar sea lion pups from Russian and Alaskan rookeries (1990-2014) to evaluate nutritional stress."

5. **Ann-Christine Zinkann**, College of Fisheries and Ocean Sciences, UAF
   "Contribution of microbially-derivsed carbon sources to Chukchi Sea benthic food webs."
6. **Jared Siegel**, College of Fisheries and Ocean Sciences, UAF
   "Changing size and age of Arctic-Yukon-Kuskokwim Chinook Salmon."
7. **Sarah Traiger**, College of Fisheries and Ocean Sciences, UAF
   "Supply or survival: Does spore dispersal or gametophyte survival limit the distribution of bull kelp, Nereocystis luetkeana, in glacially-influenced estuaries."
8. **Till Baumann**, International Arctic Research Center, UAF
   "Arctic tides under the influence of changing sea ice."
9. **Katie Shink,** College of Fisheries and Ocean Sciences, UAF
   "Trophic ecology of Arctic lamprey (Lethenteron camtschaticum) in the Bering Sea."
10. **Stefan Tangen**, School of Natural Resources and Extension, UAF
    "How can climate adaptation planning address threats to infrastructure in Alaskan communities."
11. **Yoko Kugo**, College of Liberal Arts, UAF
    "Illiamna Yup'ik Place Names: Changes in Landscape and Local Environment in Southwest Alaska."
12. **Genevieve Johnson**, College of Fisheries and Ocean Sciences, UAF
    "Using genotyping by sequencing population genetics approaches to determine the variation among individuals and populations of Tanner crab (Chionoecetes bairdi) in Alaska."

Table 3: Pie chart displaying TASK 1 breakdown over period 1 April 2016-31 March 2017.



Highlights of CIFAR Research Activities

CIFAR's modest but diverse research portfolio covers a breadth of activities from observational monitoring of key environmental parameters to the development of operational products to serve NOAA. Training students continues to be a focus of CIFAR to contribute to workforce development and students are highlighted in boldface. CIFAR-funded students have been well-trained as young scientists and are ready to contribute to NOAAs mission.

Ecosystem Studies and Forecasting

CIFAR PI Russell Hopcroft along with Katrin Iken and Eric Collins participated in the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF, www.caff.is) working group which has developed the multi-national Circumpolar Biodiversity Monitoring Program (CBMP, www.cbmp.is). The CBMP seeks to coordinate pan-Arctic biodiversity monitoring through an international network of scientists working in conjunction with national agency representatives. The overall purpose of the CBMP is to determine the status of, and any changes within, six major components of Arctic biodiversity. These Expert Networks, each with equal representation by all primary participant countries, are tasked with coordination, data integration and data synthesis. During FY17, the primary task was the completion of the State of the Arctic Marine Biodiversity Report (SAMBR) to follow the Arctic Biodiversity Assessment (ABA) Report. This project documents the state and examines the potential impacts of climate change in circumpolar Arctic domain. It provides interaction between the member countries of the Arctic Council.

CIFAR PI Hajo Eicken convene the 2016 Arctic Science Summit Week (ASSW) and Arctic Observing Summit (AOS) at the University of Alaska Fairbanks in March 9-20, 2016. ASSW is an annual gathering of international organizations engaged in supporting and facilitating Arctic research that is designed to strengthen collaborations across academia, government agencies, local communities, industry, non-governmental organizations, and other Arctic stakeholders. ASSW 2016 (http://assw2016.org/) was held in conjunction with the AOS (http://www.arcticobservingsummit.org/), the Arctic Council Senior Arctic Officials (SAO) Meeting, the International Arctic Assembly, and other local events and side meetings. The AOS is an international, biennial forum of scientists, agencies, Indigenous Peoples' organizations, Arctic community members and the private sector. The goal of the AOS is to coordinate the design, development and implementation of an international, comprehensive and sustained pan-Arctic observing system. The development and planning of the AOS is led by the International Study of Arctic Change (ISAC) in partnership with the Sustained Arctic Observing Networks (SAON) initiative and local organizers. The AOS is an outreach event of SAON, which is co-led by the Arctic Council via the Arctic Monitoring and Assessment Programme (AMAP) and the International Arctic Science Committee (IASC). There was an extensive outreach and educational component that created opportunities for conference participants to network, and local and state representatives to become involved in Arctic issues.

Climate Change and Variability

Atmospheric Sciences Ph.D. student **Till Baumann** is researching tides in the Arctic Ocean (at the Laptev Sea continental slope). In the otherwise rather calm Arctic Ocean, it has been theorized that tidal currents may play an important role in mixing processes which in turn have direct impact on the sea-ice cover. However, this theory has been difficult to test because direct observations, particularly in winter, are sparse in the Arctic. With a host of spatially and temporally high resolution velocity measurements, Till is helping analyze how tidal currents change over the course of the year and how and when they may interact with the sea-ice. An interesting preliminary result is that the depth of the strongest tidal currents

(~ 15cm/s) over the continental slope increases in winter to around 70m depth and decreases again towards summer, reaching the surface mixed layer in the ice-free time. He will work on identifying tidally active regions, quantifying associated mixing and vertical heat transport and drawing connections to the sea-ice cover and how this relationship may change in a changing Arctic Ocean.

PI Thomas Heinrichs leads a collaborative team at Geographic Information Network of Alaska (GINA) to deliver additional polar orbiting satellite imagery for use by NOAA/NWS in Alaska. Based on needs of the National Weather Service, GINA develops cryospheric products, assimilates products into models, and prepares products for hazardous weather. This work is achieved through collaboration with the NWS Weather Forecast Offices (WFOs), the Alaska Pacific River Forecast Center (APRFC), the Alaska Aviation Weather Unit (AAWU), and the Alaska Sea Ice Program (SIP), and the NOAA research partners: Cooperative Institute for Meteorological Satellite Studies--CIMSS, Cooperative Institute for Research in the Atmosphere—CIRA, NOAA Center for Satellite Applications and Research--STAR, Short-term Prediction Research and Transition and Center-- SPoRT, and the NOAA National Operational Hydrologic Remote Sensing Center (NOHRSC).

Coastal Hazards

PI Franz Mueter collaborated with Phil Mundy of the Alaska Fisheries Science Center and a Ph.D. student (**Jen Marsh**) to provide supporting science to the US delegation to the Fourth Meeting of scientific experts on fish stocks of the Central Arctic Ocean. They first reviewed and compiled the relevant literature on Polar cod (*Boreogadus saida*) to provide a definitive bibliography on the topic. They also compiled literature about other fishes that occur in the central Arctic Ocean and surrounding seas that may have ecological or commercial significance. They summarized the state of knowledge on the occurrence, distribution and abundance of fish and shellfish of the central Arctic Ocean and adjacent waters in *Synthesis of Knowledge on Fisheries Science in the Central Arctic Ocean.*

PI Martin Stuefer evaluated the GOES-R Advanced Baseline Imager (ABI) Volcanic Ash Algorithm (VAA) baseline product with case studies using the Weather Research Forecasting model with inline Chemistry (WRF-Chem). This study provides pathways to implement the ABI VAA in NOAA's operational Rapid Refresh modeling system and the work aims to improve NWS operational numerical weather prediction capabilities for aviation hazard support. Knowledge of the location and amount of volcanic ash is critical for NOAA and the NWS in their role to maintain the Anchorage and Washington Volcanic Ash Advisory Centers (VAAC). Satellite data from any volcanic ash algorithm, including the GOES-R products, can only determine the ash cloud location and mass loadings at one instant in time.

Publications and Presentations

In this last reporting period, there are 7 peer-reviewed completed publications, two publication at the stage of revision and four publications in preparation A total of 24 conference presentations (both national and international) were reported for the period 1 April 2016–31 March 2017.

TASK I: AMBON TRAINEESHIPS

Arctic Marine Biodiversity Observing Network (AMBON) student traineeships

Katrin Iken, PI
University of Alaska Fairbanks

CIFAR theme: Ecosystem Studies and Forecasting

NOAA Goal: Healthy Oceans

Amendments 30, 35, 52 NOAA Office: NOS, Gabrielle Canonico, Sponsor
Budget Amounts: Cumulative $281,228, This year $85,322 (Amendment 52)
This project is set to end 06/30/2018.

Primary objectives

This project provides funding to train graduate students whose research will be aligned with the Arctic Marine Biodiversity Observing Network (AMBON) for a period of 4 years. Students will be trained in the fields of benthic ecology, food web ecology, microbial ecology, molecular techniques, and metagenomics analyses.

Students will be receiving education, research, and outreach experience in this NOAA initiative to develop a demonstration project through the National Ocean Partnership Program (NOPP) as a first step toward developing an operational Marine Biodiversity Observation Network (BON) in the U.S. These students will be mentored by the multi-national, multi-institutional, multi-agency collaborators who form the AMBON principal investigators.

This effort, led by Katrin Iken at UAF, will provide these students with a unique opportunity to acquire research training as part of a 5-year research program covering two field seasons in an understudied marine environment that is subject to rapid climatic and resource management challenges. As a part of the AMBON/CIFAR graduate student traineeships, these students will gain education and training that will be valuable to NOAA's strategic needs in both climate services and ocean resource management, and continues CIFAR's priority on graduate student education and outreach.

Research accomplishments/highlights/findings

One PhD student (Ann-Christine Zinkann) is working on the benthic community and food web portion of the project. She collected samples during the AMBON 2015 cruise and has since started processing these samples. This involved learning some new state-of-the-art techniques in compound-specific stable isotope analyses. She helped implementing these new techniques here at the University of Alaska Stable Isotope Facility and has since been teaching other students in the technique. This new technique allows her to distinguish carbon sources in the diet of marine consumers, coming from marine photosynthetic, marine microbial, and terrestrial photosynthetic production. Her first results on this front clearly show different carbon sourcing patterns in various benthic feeding types, such as between suspension feeders, deposit feeders, and predators. This topic builds on the AMBON food web objective but presents a significant extension in scope of that objective, including new, innovative analysis techniques (amino acid-specific stable isotope analysis and fingerprinting) that she will apply and refine for her project. Ann is making excellent progress. She is also planning new experimental work that will investigate the response of sediment microbes to temperature variation in the context that warmer temperatures are likely to support higher microbial production at the base of the food web. She will include all this work into an Ecopath modeling approach for which she will soon participate in a 3-week intensive course in ecosystem modeling at the University of Vancouver, BC, under leadership of Villy Christensen. This diversity in her

work allows Ann to interact with a variety of senior researchers in various fields and forge valuable connections and collaborations that will suit her well in her future career as a young scientist.

One student (Kelly Walker) gained valuable data management experience. This student had the opportunity to organize large species data files (epifauna and fish) and learn proper quality control procedures, working with pivot tables and changing to matrix-style data formats, as well as developing appropriate metadata for data publication. This is an important tool that is normally not sufficiently stressed in student education. The obligation to publish data created with federal funds makes this a\n essential knowledge skill in young scientists though.

One student (Brian Ulaski) has learned a variety of molecular analytical tools and has processed all of the AMBON 2015 seawater samples for microbial diversity analysis. He completed DNA extractions and conducted high-throughput 16S and 18S ribosomal RNA amplicon sequencing, identifying over 800 taxa of eukaryotes (mostly protists, but also including 140 animals), 1300 bacterial taxa, and 50 Archaeal taxa. He created the first ever maps of microbial diversity across the Chukchi Sea, and is is engaging in a n international collaboration with Norwegian colleagues to compare results from the Chukchi Sea to those from the Barents Sea in the first large-scale cross-Arctic analysis of microbial diversity. This student is currently writing up the results for peer-reviewed publication.

One student (Kyle Dilliplaine) also mastered several molecular analytical tools and extracted DNA from AMBON 2015 benthos samples and worked on methods development for experimental protocols related to the extraction and single-molecule sequencing of full-length mitochondrial and chloroplast DNA from meiofauna. These are novel, state-of-the-art approaches that provide the student with a competitive edge in the fast-developing world of molecular genetics. We expect to obtain meiofauna sequences by early summer.

NOAA relevance/societal benefits

AMBON will provide information on ecosystem components that are currently not part of long-term observation programs in the Chukchi Sea, namely the microbial and other small size fractions, the epifauna and fish components, and functional diversity through food webs. All students in this traineeship program are deeply involved with these novel aspects of the AMBON project. Through integration with other programs such as the Distributed Biological Observatory (DBO), this benefits our larger Arctic ecosystem understanding and will improve our detection of biodiversity trends and changes. The AMBON will increase our ability to forecast possible changes, which will be useful to inform the various audiences, from managers to scientists. Through this educational effort, students are gaining invaluable research experience and complete their thesis research with direct involvement of multi-national, multi-institutional, multi-agency researchers.

Partner organizations and collaborators

In addition to NOAA, funders include the Bureau of Ocean Energy Management (BOEM) and the Shell Exploration and Production Company. Shell has since withdrawn its support, but we were recently able to garner some support from the National Science Foundation for additional support for ship time in summer 2017, which will also benefit further the student education and training. Besides UAF, AMBON collaborators are from the University of Maryland Center for Environmental Science, the University of Washington Applied Physics Lab, the U.S. Fish and Wildlife Service, NOAA, and the Alaska Ocean Observing System.

Impact

This project will accomplish two major impacts: (1) training for graduate students in novel research approaches and in working with a multi-discipline research team, and (2) innovative thesis research that will improve our knowledge of the biodiversity of the U.S. Chukchi Sea continental shelf.

NON-COMPETITIVE PROJECTS, BY CIFAR THEME:

Ecosystem Studies and Forecasting

Including RUSALCA (Russian-American Long-term Census of the Arctic) projects

Climate Change and Variability

Coastal Hazards

RUSALCA Overview: Joint Russian–American Long-term Census of the Arctic research program in the Bering and Chukchi Seas

The Russian–American Long-term Census of the Arctic (RUSALCA), a joint U.S.–Russia research program in the Bering and Chukchi Seas, focuses on sampling and instrument deployment in both U.S. and Russian territorial waters and operates under the auspices of two Memoranda of Understanding between NOAA and, respectively, the Russian Academy of Sciences and Roshydromet. The RUSALCA objectives are to support NOAA's Climate Observation and Analysis Program and the Russian interagency Federal Target Program "World Ocean." It also provides some of the Arctic components of international and national climate observing systems including Global Earth Observation System of Systems (GEOSS), Global Climate Observing System (GCOS), and Integrated Ocean Observing System (IOOS). RUSALCA has also contributed to the U.S. interagency Study of Environmental Arctic Change (SEARCH) Program, NOAA's Office of Ocean Exploration and the Census of Marine Life (CoML).

The RUSALCA program is focused on gathering long-term observations towards understanding the causes and consequences of the reduction in sea ice cover in the northern Bering Sea and the Chukchi Sea in the Arctic Ocean. Models suggest that the expected changes in sea ice and albedo in this area will translate to significant alterations in water column structure and flow and in associated ecosystems. The program began in summer 2004 with a multidisciplinary cruise on the R/V *Khromov*, a Russian ice-strengthened research ship, to investigate water column physics, nutrient chemistry, and pelagic and benthic biology. Oceanographic moorings were deployed in the western portion of the Bering Strait in 2004, and recovered and redeployed yearly. For 2007 and beyond, the RUSALCA program had planned an annual cruise focused on the physics in the Bering Strait region and more extensive multidisciplinary cruises in 2009 and 2012 in the northern Bering and Chukchi Seas depending on resources.

During the reporting period, RUSALCA efforts were focused primarily on data analysis and synthesis with limited analyses of additional samples collected from mooring cruises.

Goals of the overall RUSALCA program

1. **Make physical, chemical, and ecological observations where Arctic sea ice is diminishing**
2. **Monitor fresh water and nutrient fluxes via long-term moorings in Bering Strait**
3. **Monitor ecosystem indicators of climate change**
4. **Improve international Arctic science collaboration**
5. **Explore the unknown Arctic**

Project reports for CIFAR awards associated with the RUSALCA program follow this overview, and reflect current synthesis efforts.

RUSALCA: A synthesis of long-term observations of Pacific-Arctic zooplankton communities

Russell R. Hopcroft, PI ***CIFAR theme: Ecosystem Studies and Forecasting***
University of Alaska Fairbanks

Other investigators/professionals associated with this project:
Ksenia Kosobokova, Russian partner, Russian Academy of Sciences, Moscow

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendments 4, 14, 36 NOAA Office: OAR, Jeremy Mathis, Sponsor
Continued research from NA08OAR4320870
Budget Amounts: Cumulative $147,052, This year $0
This project is complete.

Primary objectives

We propose repeated comprehensive surveys of zooplankton communities in the Bering Strait and Chukchi Sea to understand the transport patterns of Pacific zooplankton into the Arctic and build time-series to assess ecosystem change in this climatically sensitive region. The census will involve a combination of traditional taxonomic enumeration and identification, along with continued molecular sequencing and photographic documentation of the species collected by several types of plankton nets. This proposal builds on work conducted since 2003 in collaboration with US and Russian investigators during the previous, multi-disciplinary RUSALCA field program and the ongoing RUSALCA synthesis effort. This synergy with the established RUSALCA program adds special strength to this proposal because it (1) capitalizes on established working relationships between the PI and both US and Russian collaborators; (2) maintains consistency in sampling approaches; (3) sustains a unified group interest in targeted regions for continued time-series sampling; and (4) establishes new regions of interest for the "next generation RUSALCA program" such as an extension of sampling on the northern Chukchi shelf and exploration of the shelf/slope region in the western Chukchi Sea and eastern East Siberian Sea.

Research accomplishments/highlights/findings

The 2015 and 2016 cruises were cancelled by NOAA, due to issues with securing vessels. In 2016, Hopcroft used funds form this and a related project to add ship time to a NOAA cruise to sample DBO4 with the same gear type as used in prior years. These samples are currently undergoing analysis at UAF

NOAA relevance/societal benefits

This project examines the potential impacts of climate change in the Pacific–Arctic gateway.

Education

None to report at this time.

Outreach

None to report at this time.

Publications, conference papers, and presentations

None to report at this time.

Other products and outcomes

None to report at this time.

Partner organizations and collaborators

None to report at this time.

Changes/problems/special reporting requirements

See above, the 2015 sampling and proposed 206 sampling were cancelled.

RUSALCA: Arctic food web structure and epibenthic communities in a climate change context

Katrin Iken, PI
Bodil Bluhm, Co-PI
University of Alaska Fairbanks

CIFAR theme: Ecosystem Studies and Forecasting

Other investigators/professionals associated with this project (w/affiliation):
Ken Dunton, University of Texas at Austin

NOAA Goal: Healthy Oceans; Climate Adaptation and Mitigation

Amendments 3, 27
Budget Amounts: Cumulative $319,191, This year $0
This project is set to end on 06/30/2017.

NOAA Office: OAR-CPO, J. Mathis, Sponsor

Primary objectives

Synthesize information on food web structure and epibenthic faunal assemblages in the Chukchi Sea including their links to the physical and chemical properties of water mass characteristics. This synthesis will build on data collected during RUSALCA cruises in 2004, 2009, and 2012.

Provide an assessment of the temporal variability in the benthic food web and epibenthic community structure in relation to climatic variability.

Research Accomplishments/highlights

We have completed the work on epibenthic community structure based on taxonomic identity of the species (MS thesis of student Carlos Serratos, manuscript in revisions with the journal Arctic, see previous reports). We have now extended our approach of community structure based on taxonomic identity of species to an approach that considers the biological function of these species and analyzes community structure based on these functional characteristics. Functional diversity is defined as the range of organismal traits of species within a community that, combined, influence ecosystem functioning. Functional diversity explores what communities do as opposed to their taxonomic composition. Biological traits analysis (BTA) can be used to assess functional diversity by assigning biological traits to species based on their life history, morphology and behavior, thus identifying their function and role in a specific environment. BTA includes traits related to morphology (body form, fragility, colonial/solitary), behavior (mobility, adult movement, feeding habit, trophic level, bioturbation, depth range, surface affinity), and life history (size, adult age, reproductive strategy, larval development). Within each trait are multiple modalities that qualify each trait (see examples in Table 1).

Table 1: Five biological traits and their modalities.

Trait	Modality	Abr.	Description
Size	small	S1	<10 mm
	small-medium	S2	11-20 mm
	medium	S3	21-100 mm
	medium-large	S4	101-200 mm
	large	S5	>201 mm
Larval Development	planktotrophic	LD1	high fecundity
	lecithotrophic	LD2	medium fecundity
	direct development	LD3	low fecundity
Trophic Level	1	TL1	primary producer
	2	TL2	primary consumer
	3	TL3	secondary consumer
	4	TL4	tertiary consumer
	5	TL5	apex predator
Living Habit	free living	LH1	moves freely on the sediments
	crevice dwelling	LH2	typically cryptic on rock/coarse substrate
	tube dwelling	LH3	tube lined with sand, mucus or CaCO3
	burrow dwelling	LH4	Inhabits/ burrows in sediment
	epi/endo zoic/phytic	LH5	living on or in sediments or biotic substratum
	attached	LH6	adherent to a substratum
Feeding Habit	surface deposit feeder	FH1	scrape/ graze algal matter from surfaces.
	subsurface deposit feeder	FH2	detrital material from within the sediment
	filter/suspension feeder	FH3	e.g., sponges, corals, hydrozoas, bivalves
	opportunist/scavenger	FH4	e.g., several amphipods, omnivores
	predator	FH5	e.g., echinoderms, crustaceans
	parasite	FH6	parasites

Once these biological traits are compiled, they are fuzzy coded, a process that weights the traits on a scale from 0-3 to the represented modalities if several occur, creating trait profiles per station. Subsequently, fuzzy correspondence analysis (FCA) is used to examine which modalities have the greatest influence on variation among stations. Station trait profiles are then compared for similarity using cluster analysis.

We started functional coding of the mollusks within the epibenthic invertebrate community and present first results here. Coding of additional phyla is ongoing. We focused on the eight repeat stations sampled in 2004, 2009, and 2012 in the southern Chukchi Sea for the phylum Mollusca. Functional traits of the overall molluscan assemblage per year differed between 2004 and 2009/2012 (Fig. 1). The shift was across traits, including bioturbation characteristics, feeding habits and body form. It should be noted, however, that this shift was mostly driven by a single station in 2004 (CL6), which had an unusual species composition dominated by two bivalves, *Serripes groenlandicus* and *Pododesmus macrochisma*.

When looking at stations individually within the study years, functional groupings were more consistent among stations than within years (Fig. 2). This indicates that functional diversity at the stations was overall conserved over time, although some outlier stations occurred (CL6, CS17), at least for the mollusks.

So far, this work has served as a proof of concept that we can glean valuable information about community function and the temporal and spatial consistency of this functioning by using BTA. Following, we will continue coding other phyla to include in the next steps of this analysis.

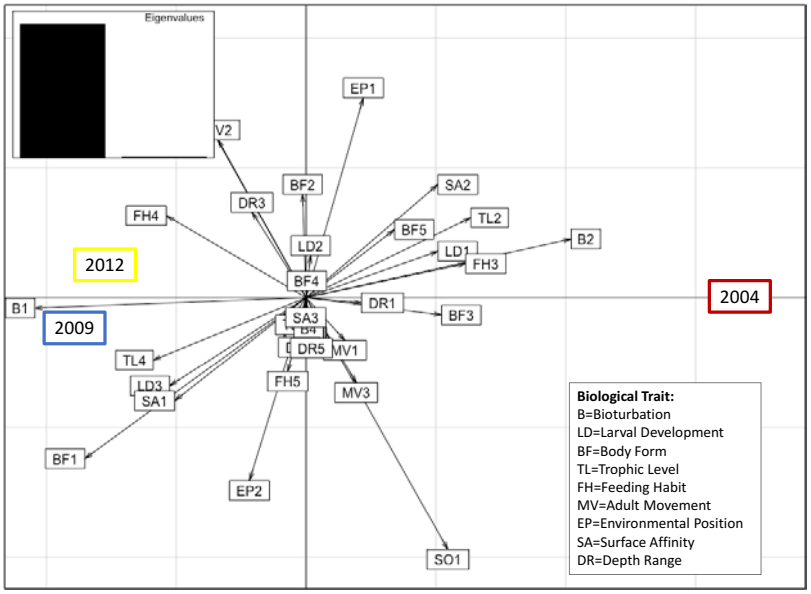


Fig. 1: FCA of biological traits of mollusk assemblages collected in the southern Chukchi Sea in 2004, 2009 and 2012. Small boxes indicate traits (letters) and modalities (numbers) with vector length and direction representing the influence these traits have on the distribution of the mollusk assemblage.

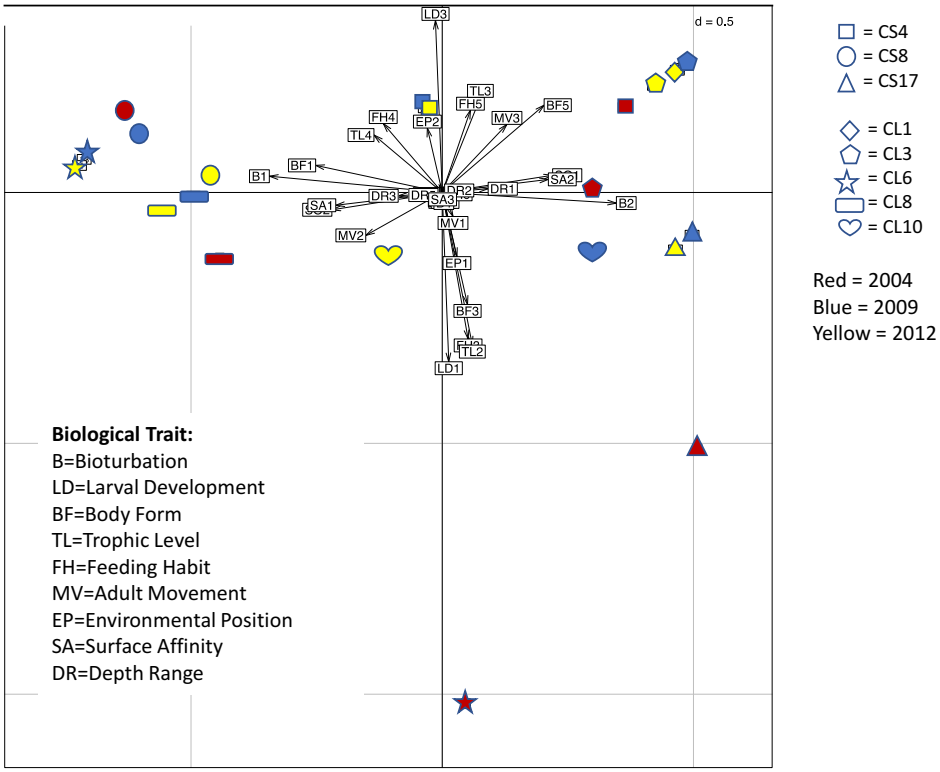


Fig. 2: FCA of biological traits of mollusk assemblages collected at eight repeat stations in the southern Chukchi Sea in 2004, 2009 and 2012. Small boxes indicate traits (letters) and modalities (numbers) with vector length and direction representing the influence these traits have on the distribution of the functional station profiles. Groupings were more consistent by station (shapes) than by year (color).

NOAA relevance/societal benefits

This work contributes to NOAA's strategic plan objective "to describe and understand the state of the climate system through integrated observations" of the biological components and the associated water mass characteristics. Increased knowledge of food web connections and epibenthic communities over the RUSALCA project study time is essential information to "understand the consequences of climate variability and changes" in the Chukchi Sea marine ecosystem. This work provides NOAA with a product that can assist to "improve society's ability to plan and respond to climate variability." Knowledge gained during the RUSALCA work has contributed to the development of the Circumpolar Biodiversity Monitoring Program (CBMP) Implementation Plan and is part of the currently developed State of the Arctic Marine Biodiversity Report (SAMBR).

Education

Graduate student Carlos Serratos has completed his M.S. degree in Marine Biology in fall 2015.

Lauren Sutton started her M.S. degree in Marine Biology in the fall 2016. She uses the epibenthic community data to perform functional trait analysis on epibenthic invertebrates in the Chukchi Sea. Her work is progressing well and she has already presented some of her work at a national conference. .

Outreach

Photographs from the RUSALCA expeditions have been used in a variety of educational and scientific materials. Recently, for example, RUSALCA photos were used in the creation of species flash cards for a marine biodiversity course to help students study for the exam. Photos also are being used to create a photo ID catalog of epibenthic invertebrates to be used for field identifications and training of graduate students. PI Iken performs regular touch tank exhibits for K-12 students with Alaskan marine invertebrates to educate them about marine life, threats to marine life and ecosystem functioning, and the need for long-term scientific monitoring.

Publications and presentations (cumulative)

Publications

Grebmeier JM, Bluhm BA, Cooper LW, Danielson S, Arrigo K, Blanchard AL, Clark JT, Day RH, Frey KE, Gradinger RR, Kedra M, Konar B, Kuletz KJ, Lee SH, Lovvorn JR, Norcross BL, Okkonen SR (2015) Ecosystem characteristics and processes facilitating persistent macrobenthic biomass hotspots and associated benthivory in the Pacific Arctic. Progress in Oceanography 136:92–114 (This paper includes RUSALCA epifauna data).

Grebmeier JM, Bluhm BA, Cooper LW, Denisenko SG, Iken K, Kedra M, Serratos C (2015) Time-series benthic community composition and biomass and associated environmental characteristics in the Chukchi Sea during the RUSALCA 2004–2012 Program. Oceanography 28: 116-133. http://dx.doi.org/10.5670/oceanog.2015.61.

Pisareva MN, Pickart RS, Iken K, Ershova EA, Grebmeier JM, Cooper LW, Bluhm BA, Nobre C, Hopcroft RR, Hu H, Wang J, Ashjian CJ, Kosobokova KN, Whitledge TE (2015) The relationship between patterns of benthic fauna and zooplankton in the Chukchi Sea and physical forcing. Oceanography 28: 68-83. http://dx.doi.org/10.5670/oceanog.2015.58.

Divine LM, Bluhm BA, Mueter FJ, Iken K (2015) Diet analysis of Alaska Arctic snow crabs (Chionoecetes opilio) using stomach contents and δ13C and δ15N stable isotopes. Deep-Sea Res II. http://dx.doi.org/10.1016/j.dsr2.2015.11.009 (This paper includes RUSALCA crab data).

Grebmeier JM, Bluhm BA, Cooper LW, Danielson S, Arrigo K, Blanchard AL, Clark JT, Day RH, Frey KE, Gradinger RR, Kedra M, Konar B, Kuletz KJ, Lee SH, Lovvorn JR, Norcross BL, Okkonen SR (2015) Ecosystem characteristics and processes facilitating persistent macrobenthic biomass hotspots and associated benthivory in the Pacific Arctic. Progress in Oceanography 136:92–114.

Serratos C, Bluhm BA, Iken K. Epibenthic community structure on the southern and eastern Chukchi Sea shelf. In revision with Arctic.

Presentations at conferences

Sutton L, Iken K. Functional diversity of epibenthic shelf communities in the Chukchi Sea using biological traits analysis. Alaska Marine Science Symposium, Anchorage AK, 24-27 Jan 2017

Degen R, Zhulay I, Bluhm B. Multi-trait approaches, a roadmap towards the understanding of future Arctic ecosystems. Arctic Frontiers Conference, Tromsø, Norway, 25-27 Jan 2017

Divine LM, Mueter FJ, Kruse GH, Bluhm BA, Iken K. New estimates of growth, size-at-maturity, mortality and biomass of snow crab, Chionoecetes opilio, in the Arctic Ocean off Alaska. Alaska Marine Science Symposium, Anchorage AK, 25-28 January 2016, Poster (This poster included RUSALCA crab data)

Schollmeier T, Iken K, Wooller MJ. Characterizing the carbon isotopic composition of dissolved inorganic carbon in sea ice pore water as a carbon source for sea ice algae in the Arctic. Alaska Marine Science Symposium, Anchorage AK, 25-28 January 2016, Poster (This poster included RUSALCA crab data)

Schollmeier T, Iken K, Wooller MJ. Characterizing the carbon isotopic composition of dissolved inorganic carbon in sea ice pore water as a carbon source for sea ice algae in the Arctic. Ocean Sciences Meeting, New Orleans 21-26 February 2016, Poster (This poster included RUSALCA crab data)

Other meetings:

MS student Lauren Sutton and co-PI Bluhm participated in (and Bluhm co-organized) the Arctic Traits Workshop, Vienna, 1-2 December 2016 and held a working group meeting with Traits collaborator Renate Degen 30 November 2016.

Partner organizations and collaborators

Iken (lead PI) and Bluhm are part of the newly funded AMBON (Arctic Marine Biodiversity Observing Network) project, which builds heavily on RUSALCA and aims to maintain the time series stations in the southern Chukchi Sea (US side only) and adds to the RUSALCA coverage by adding investigations on the northeastern Chukchi shelf. Both PIs have recently been working on snow crab population and reproductive dynamics in the Chukchi and Beaufort Seas (CMI-funded, BOEM-funded as part of Arctic EIS project), which ties together with RUSALCA epifaunal community and food web structure objectives and sampling. The connection of these projects with RUSALCA has led so several presentations and publications. Both PIs also are part of the US-Canada Transboundary project funded through BOEM that investigates epifaunal community and benthic food web structure in the Beaufort Sea in an effort paralleling our RUSALCA objectives. Bluhm was also a co-PI on the recent NPRB-funded Pacific Arctic Marine Regional Synthesis (PacMARS) project that aggregated and synthesized research across multiple disciplines in the northern Bering, Chukchi and Beaufort Seas including RUSALCA efforts.

Iken and Bluhm are members of the Marine Expert Monitoring Group of the Circumpolar Biodiversity Monitoring Program, one of the programs under the directive of CAFF (Arctic Council Conservation of Arctic Flora and Fauna), where the RUSALCA program features strongly in monitoring efforts in the Chukchi Sea region.

The PIs and M.S. student Lauren Sutton have an ongoing collaboration with Dr. Renate Degen from the University of Vienna who has obtained three years of funding for her post-doctoral research in which she creates an Arctic benthos traits data base. A related, multi-authored short position paper on the topic is in progress.

Under North Pacific Research Board (NPRB) and Norwegian funding, Bluhm is working with Russian collaborators (several of which are involved in RUSALCA) on editing English versions of Russian-authored taxonomic identification keys for Arctic fauna in an effort to both provide better access to identification material and uniform identifications between Russian and western Arctic researchers. An online photo ID catalogue also is part of the AMBON project objectives and pictures and identifications done during RUUSALCA are part of this effort.

Publications related to this project, funded under previous cooperative agreements:

See above – since all recent publications include time series data, these publications include data from pervious RUSALCA awards

Continuation of RUSALCA fish ecology research

Brenda L. Norcross, PI
Brenda A. Holladay, Co-PI
University of Alaska Fairbanks

CIFAR theme: Ecosystem Studies and Forecasting

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendments 1, 24
Continues research from NA08OAR4320870
Budget Amounts: Cumulative $144,833, This year $0
This project is on a no cost extension until 06/30/2018.

NOAA Office: OAR-CPO, Jeremy Mathis, Sponsor

Primary objectives

To synthesize and publish results of the fish ecology investigations of larval and demersal fishes during the 2004, 2009, and 2012 cruises of the Russian-American Long-term Census of the Arctic (RUSALCA) to provide for better understanding of fish distribution, abundance, and demersal species associations in the present-day Chukchi Sea.

Planned publications will also incorporate data from the extensive fish surveys we have conducted in the eastern Chukchi Sea from 2007 to 2010 under non-RUSALCA funding.

Research accomplishments/highlights/findings

During the past year, all efforts have been on preparing manuscripts for publication.

Published online in 2015 and described in our 2016 Annual Report, the article by Gleason et al. (2016) is now in print in a special issue of Marine and Freshwater Research that focused on various aspects of fish otoliths.

The microchemistry of otoliths has the potential to reconstruct fish movement patterns and habitat use between environmentally different habitats for individual age classes of Arctic marine fish. Herein, we tested the relationship between the bottom water mass from which a fish was collected and the microchemistry of the most recent growth edge of the fish's otolith using Mg, Sr, Ba and Ca, and then determined the physical and biological factors that affected the chemical signatures. A discriminant function post hoc analysis of fish occupying bottom water masses resulted in 76% correct classification of Arctic or Polar cod (Boreogadus saida) and 82% correct classification of Arctic staghorn sculpin (Gymnocanthus tricuspis) into bottom water masses of capture when ages were pooled. By separating age classes, correct classifications into water masses of capture were as high as 87% for Arctic cod (three water masses) and 90% for Arctic staghorn sculpin (two water masses). Otolith Ba:Ca, Mg:Ca and Sr:Ca ratios were most consistently affected by bottom water temperature; the latter two were also affected by fish age and fish length. The use of otolith microchemistry to determine occupancy of water masses over time is most promising for Arctic cod, which is widespread and occupies the most thermally diverse habitats in Arctic waters.

Although we have other manuscripts drafted, none are ready to submit to peer-reviewed journals for publication. A manuscript concerning ichthyoplankton abundance and distribution during the 2004, 2009 and 2012 RUSALCA biological cruises is close to completion. The present draft is undergoing in-house review at the Alaska Fisheries Science Center in Seattle, WA. We plan to submit this to a journal such as

Polar Biology during the next year. Busby, Holladay, Norcross, Mier. Ichthyoplankton of the Chukchi Sea 2004–2012: Russian-American Long-Term Census of the Arctic.

The significant findings are as follows: Larval fish species, number, size and location are strongly related to timing of cruise as well as cruise track. The timing of the cruises ranged from early August in 2004 to late September in 2009, with the 2012 occurring between those times. More larval/juvenile fish were captured in bongo plankton nets when sampling was early in the ice-free season. For example, abundance of Arctic Cod was greatest in 2004 and lowest in 2009; mean standard length was greater in September 2009 than in August 2004 or 30 August 2012. Diversity of ichthyoplankton was significantly greater in 2004 than 2009. We concluded that in 2009 most larval fishes were older than in the 2004 and 2012 cruises, and that they had likely grown larger than the size normally captured in bongo nets or may have settled out of the water column. Based on this analysis, we make recommendations for future surveys to continue using the bongo net deployed during the 2004, 2009 and 2012 RUSALCA cruises and add another net that will catch fish larvae in later stages of development.

Additional manuscripts are underway, but no substantial progress has been made in the past year.

Bluhm, Holladay, Huettmann, Iken, Norcross, Sirenko. Interactions of epibenthic invertebrates and fish community structure in the Chukchi Sea. This includes field collections from 2004, 2009 and 2012 RUSALCA cruises, 2007 and 2008 Japanese R/V Oshoro-Maru cruises and a 2007 NOAA Bering-Aleutian Salmon International Survey (BASIS) cruise. A preliminary draft of this manuscript has been written and several iterations have been passed among the authors. We expect to submit to a journal during the coming year.

The significant findings include: fish to epifauna biomass ratios may be a useful indicator of carbon flow patterns and ecosystem conditions that is worth monitoring over time.

Two drafts of this manuscript have been circulated, but substantial progress was not made this year. Holladay, Chernova, Mecklenburg, Norcross, Voronina. Working title: Spatial and temporal variability in fish communities of the Chukchi Sea, 2004–2012. This includes 2004, 2009, and 2012 RUSALCA cruises. We expect to submit this to a journal such as Polar Biology during the next year.

Significant findings include: The basic content of dominant species in communities was stable. The list of five most common and numerous fishes was the same over years. No dramatic changes in fish fauna of the Chukchi Sea were detected during the years 2004–2012.

NOAA relevance/societal benefits

This project adds to the coordinated RUSALCA effort of identifying factors that underlie ecosystem change in the Arctic. Our research develops a broad-scale baseline of abundance and distribution of larval and demersal fishes throughout the Chukchi Sea and identifies the physical mechanisms affecting fish distribution, thereby directly supporting the RUSALCA objective of developing methods of identifying ecosystem change. Also through this research we tested methods to use trace elements to determine association of fish and their environment, with the potential for determining movement of fish in the Chukchi Sea.

Partner organizations and collaborators

None to report at this time.

Impact

Trace elements in fish otoliths are indicators of water mass occupancy; this concept was proven in the Gleason et al. paper (2016). The Norcross lab is now applying this to Arctic Cod otoliths in Chukchi and Beaufort Seas and around Pt. Barrow.

Education

None this reporting period.

Outreach

None this reporting period.

Publications

Gleason, C.M., B.L. Norcross, K.J. Spaleta. 2016. Otolith chemistry discriminates water mass occupancy of Arctic fishes in the Chukchi Sea. Marine and Freshwater Research 67: 967–979, http://dx.doi.org/10.1071/MF15084.

Conference presentations

None this reporting period.

Other products and outcomes

None this reporting period.

RUSALCA: Global change in the Arctic: Interactions of productivity and nutrient processes in the northern Bering and Chukchi Seas

Terry E. Whitledge, PI
Dean A. Stockwell, co-PI
University of Alaska Fairbanks

CIFAR theme: Ecosystem Studies and Forecasting

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendments 2, 22
Continues research from NA08OAR4320870
Budget Amounts: Cumulative $214,169, This year $0
This project is set to end on 06/30/2017.

NOAA Office: OAR-CPO, Jeremy Mathis, Sponsor

Primary objectives

Investigate whether measurable changes have occurred in nutrient properties, biomass of phytoplankton and photosynthetic production of organic matter in the Bering Strait/Chukchi Sea using the nine years of RUSALCA data.

6. **Analysis of nutrient, chlorophyll and primary production samples**
7. **Prior RUSALCA nutrient/chlorophyll data from mooring cruises were calculated edited and quality checked**
8. **Data for nutrients, chlorophyll and primary production will be sent to designated archive for inclusion in RUSALCA database.**
9. **Data products are planned for presentation at one or two national meetings.**
10. **Collaborative manuscripts will be prepared with physical, chemical, biological and microbiological groups either as lead author or contributing author. It is expected that at least two additional manuscripts will be prepared that emphasize physical-nutrient processes, nutrient primary productivity processes and nutrient-primary production-microbial processes.**

Research Accomplishments/highlights

Primary production rate measurements using carbon and nitrogen isotopes were analyzed and combined with nutrient data for inclusion in a joint publication of the journal Oceanography.

NOAA relevance/societal benefits

This project will determine the amount of nutrients that are available to support primary production in the seasonally ice-covered waters of the Chukchi Sea and compare to prior data collected over the prior two decades to assess changes that are related to climate change.

Education

A Ph.D. student has been employed to process, collate, aid in the analysis of nutrient data obtained during RUSALCA cruises and place nutrient data with accessible data bases.

Publications and presentations

Ahn, S.H., S.H. Lee, T.E. Whitledge, D.A. Stockwell, J.H. Lee and H.W. Lee. Submitted. Biochemical composition of phytoplankton in the Laptev and East Siberian seas during the summer, 2013. Journal of Geophysical Research Oceans.

Pisareva, M.N., R. Pickart, M.A. Spall, C. Nobre, D.J. Torres, G.W.K. Moore and T.E. Whitledge. 2015. Flow of Pacific water in the western Chukchi Sea: Results from the 2009 RUSALCA expedition. Deep-Sea Research I 105: 53-73.

Pisareva, M.N., R.S. Pickart, K. Iken, E.A. Ershova, J.M. Grebmeier, L.W. Cooper, B.A. Bluhm, C. Nobre, R.R. Hopcroft, H. Hu, J. Wang, C.J. Ashjian, K.N. Kosobokova, and T.E. Whitledge. 2015. The relationship between patterns of benthic fauna and zooplankton in the Chukchi Sea and physical forcing. Oceanography 28(3):68–83, http://dx.doi.org/10.5670/oceanog.2015.58.

Yun, M.S., T.E. Whitledge, D. Stockwell, S.H. Son, J.H. Lee, J.W. Park, D.B. Lee, J. Park and S.H. Lee. 2016. Primary production in the Chukchi Sea with potential effects of freshwater content. Biogeosciences 13:737-749

Lee, S.H., J.H. Lee, H. Lee, J. H. Lee, D. Lee, S. An, H.T. Joo, D.A. Stockwell and T.E. Whitledge. In Prep. Light-limited uptake rates of carbon and nitrogen of phytoplankton in the Laptev and the East Siberian seas. Geophysical Research Letters

Partner organizations and collaborators

Dr. Sang Heon Lee and four Ph.D. students, Department of Oceanography, Pusan National University, Busan 609-735, South Korea

Publications related to this project, funded under previous cooperative agreements

Pisareva, M.N., R. Pickart, M.A. Spall, C. Nobre, D.J. Torres, G.W.K. Moore and T.E. Whitledge. 2015. Flow of Pacific water in the western Chukchi Sea: Results from the 2009 RUSALCA expedition. Deep-Sea Research I 105: 53-73.

Pisareva, M.N., R.S. Pickart, K. Iken, E.A. Ershova, J.M. Grebmeier, L.W. Cooper, B.A. Bluhm, C. Nobre, R.R. Hopcroft, H. Hu, J. Wang, C.J. Ashjian, K.N. Kosobokova, and T.E. Whitledge. 2015. The relationship between patterns of benthic fauna and zooplankton in the Chukchi Sea and physical forcing. Oceanography 28(3):68–83, http://dx.doi.org/10.5670/oceanog.2015.58.

Yun, M.S., T.E. Whitledge, M. Kong, S.H. Lee, 2014. Low primary production in the Chukchi Sea shelf, 2009. Continental Shelf Research 76: 1-11

Lee, S.H., D.A. Stockwell, H.M. Joo, Y.B. Son, C.K. Kang, T.E. Whitledge. 2013. Phytoplankton production from melting ponds on Arctic sea ice. Journal of Geophysical Research.117, C04030, doi:10.1029/2011JC007717.

C Lee, S.H., M.S. Yun, J.H. Lim, B.K. Kim, E.J. Choy, C.K. Kang, T.E. Whitledge. 2013. Contribution of small phytoplankton to total primary production in the Chukchi Sea. Continental Shelf Research 68:43-50.

Lee, S.H., M.S. Yun, B.K. Kim, S. Saitoh, C.K. Kang, S.H. Kang, T.E. Whitledge. 2013. Latitudinal carbon productivity in the Bering and Chukchi Seas during the summer in 2007. Continental Shelf Research 59:28-36.

Alaska Ocean Acidification (OA) Research: Autonomous observations of OA in the Alaska coastal ocean

Jessica N Cross, PI
NOAA Pacific Marine Environmental Laboratory

CIFAR theme: Ecosystem Studies and Forecasting

Other investigators/professionals associated with this project:
Natalie Monacci, University of Alaska Fairbanks

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendment 34
Budget Amounts: Cumulative $100,000, This year $0
This project is closed.

NOAA Office: OAR, Libby Jewett, Sponsor

Primary objectives

This project provides support for ongoing monitoring through the GAKOA surface buoy, a time series site in the central Gulf of Alaska, and the M2 surface buoy (Peggy), a time series site in the southeastern Bering Sea. It also provides support for ongoing subsurface monitoring at the M2 and M8 time series sites in the southeastern Bering Sea.

Research accomplishments/highlights/findings

GAKOA 2016 deployment notes (Gulf of Alaska surface buoy):
Upon turnover of the MAPCO2 surface system at this site in March 2016, seawater CO 2 concentrations showed a sharp drop (50%) during April, coincident with the start of the spring bloom. As compared with older data collected by the Ocean Acidification Research Center at the University of Alaska, this bloom appears to have been starting earlier since the beginning of the data record. The 2016 spring bloom set a record for annual CO2 minimum. However, this drawdown moderated more quickly than in previous years. CO 2 concentrations remained low through May and June, and slowly began to recover to atmospheric levels starting in July.

Peggy 2016 deployment notes (Bering Sea surface buoy):
Upon turnover of the MAPCO2 surface system at this site, seawater CO 2 concentrations were low, showing the drawdown typical of the spring bloom. However, the signal from the surface MAPCO2 system quickly deteriorated, and it is unclear if any of the data collected during the initial few weeks of deployment is actually usable. SAMI pH data was also collected during this deployment. The data quality from this instrument was much higher, indicating some of the first successful pH data return at this site since the start of data collection.

M2 2016 deployment notes (Bering Sea bottom package, 67 m):
For the fall 2016/2017 deployment, a SAMI pCO 2 sensor was deployed alongside a SeaFET pH sensor (Satlantic). The 67 m depth of the sensor package at this site knowingly exceeds the depth rating for the

SeaFET, which was revised to 40 m during a previous 67 m deployment by OARC. When exceeding the depth rating, OARC has found that the failure rate of SeaFET sensors is similar to the overall cold-weather failure rate of the SAMI sensors. These sensors did collect data during the deployments. Data processing and QA/QC is ongoing.

NOAA relevance/societal benefits

Coastal regions around Alaska are experiencing the most rapid onset of ocean acidification (OA) compared to anywhere else in the U.S. Recent research using OA forecast models as well as species and human impact assessments have shown that Alaska coastal communities and the vast fisheries that support them have a varying degree of vulnerability to OA, ranging from moderate to severe (Mathis et al., 2014). The most vulnerable communities rely heavily on the economic and nutritional value of fisheries and other ecosystem services. OA in Alaska also has the potential to have cascading economic impacts well beyond the state level. Because Alaska fisheries provide over $3 billion annually to the U.S. gross domestic product (GDP), even a relatively small decline in one or more of the fisheries in the Gulf of Alaska or Bering Sea could have a very large net economic impact—large enough to dwarf the combined impacts occurring in other U.S. areas.

Partner organizations and collaborators

This project represents a close collaborative relationship between the Pacific Marine Environmental Laboratory and the Ocean Acidification Research Center at the University of Alaska, Fairbanks. These mooring data also contribute to the International Ocean Observing System (IOOS) program and the Global Ocean Acidification Observing Network (GOA-ON).

Impact

The researchers involved with this project also work closely with the Alaska Ocean Acidification Observing Network, an impact-driven group designed to connect scientists to stakeholders. Through that group, these monitoring activities support a number of cross-cutting research efforts. Firstly, the time series provides new insights into the seasonal progression of OA events caused by the progressive accumulation of anthropogenic CO_2 into the region's coastal seas. The mooring data can also be used as an early warning system for stakeholders around the state, as well as to provide information for other types of OA research. Other projects within the OAP Alaska Enterprise focus on laboratory based evaluation of the impact of OA on commercially and ecologically important Alaskan species, especially during the vulnerable larval and juvenile life stages. This environmental monitoring informs those studies by describing the intensity, duration, and extent of OA events and providing a baseline for projecting future conditions. Finally, this observational data is used to validate new OA models that are currently being developed for the Gulf of Alaska and Bering Sea, and are applied in bio-economic models of crab and pollock abundance forecasts.

Publications

Cross, J.N., Mathis, J.T., W. Evans, and N. Monacci. The Physical and Biogeochemical Influences on Ocean Acidification in the Northern Gulf of Alaska, Journal of Geophysical Research, in preparation.

Cheng, W., Cross, J.N., and Mathis, J.T., Future projections of ocean acidification in the Gulf of Alaska from the CCSM4 model. Geophysical Research Letters, in preparation.

Conference presentations

Cross, J.N., Mathis, J.T., Foy, R., Hurst, T., Sigler, M., Dalton, R., Stone, R., 2017. US Arctic and Alaska Ocean Acidification: Current monitoring efforts, trends, and areas of highest concern. NOAA Ocean Acidification Program PI Meeting, Seattle, WA, January 2017.

Cross, J.N., Mathis, J.T., Monacci, N.M., 2017. Ocean acidification in Alaska: Ecosystem and Economies. Alaska State Legislature House Resources Committee, Juneau, AK, February 2017.

Cross, J.N., Mathis, J.T., 2016. Ocean acidification in Alaska: OA basics, current monitoring efforts, trends, and areas of highest concern. Alaska Ocean Observing System Ocean Acidification PI Meeting, Anchorage, AK, November, 2016.

Cross, J.N., Mathis, J.T., 2016. Ocean acidification in Alaska: OA Ecosystems and Economies. NOAA Pacific Marine Environmental Laboratory, Seattle, WA, November 2016.

Cross, J.N., Mathis, J.T., Monacci, N.M., 2016. Ocean Acidification in Alaska: Introduction and Integrated Monitoring. Aleutian Life Forum, Dutch Harbor, AK, May 2016.

Synthesis of Arctic Research (SOAR): CO2 fluxes and Ocean Acidification in a Rapidly Changing Arctic

Jessica Cross, PI
NOAA Ocean Acidification Research Center
University of Alaska Fairbanks

CIFAR theme: Ecosystem Studies and Forecasting

Other investigators/professionals associated with this project:
Natalie Monacci, University of Alaska, Fairbanks

NOAA Goals: Healthy Oceans; Climate adaptation and mitigation

Amendment: 55 NOAA Office: OAR, Phyllis Stabeno, Sponsor
Budget Amounts: Cumulative $40,000, This year $40,000 (Amendment 55)
This project is new and closed.

Primary objectives

The Synthesis of Arctic Research (SOAR) aims to bring together a multidisciplinary group of Arctic scientists and Alaskan coastal community representatives to explore and integrate information from completed and ongoing marine research in the Pacific Arctic Region. The goal of the SOAR project is to increase scientific understanding of the relationships among oceanographic conditions, benthic organisms, lower trophic pelagic species (forage fish and zooplankton), and higher trophic species (seabirds and marine mammals) in the Pacific Arctic, with particular emphasis on the Chukchi Sea Lease Sale Areas. The SOAR project is supported by the Bureau of Ocean Energy Management (BOEM) and NOAA, and led by Dr. Sue Moore (NOAA/S&T), Dr. Phyllis Stabeno (NOAA/PMEL), and an 11-member Science Steering Committee.

SOAR Phase I resulted in a special issue of *Progress in Oceanography* including 16 synthetic papers. The major product of SOAR Phase II will be a collection of peer-reviewed scientific publications in a special issue or theme section of an appropriate journal. The work proposed here will result in a manuscript on this topic in a peer-reviewed journal.

Research accomplishments/highlights/findings

The Arctic Ocean is undergoing a rapid transition that will have profound consequences for the carbon biogeochemistry of the region, especially the sea-air fluxes of carbon dioxide (CO2) and ocean acidification. Here, we will synthesize the existing datasets to develop a better understanding of the underlying controls on these processes and begin to quantify the trajectories that will lead to future states. During the past decade, several dozen new dataset have become available that will serve as a foundation for this synthesis effort. For this project, we assimilated physical, chemical, and biological datasets to produce the first-ever integrated assessment of ocean acidification in the Arctic Ocean. The analysis of this data has been accepted to the SOAR synthesis published as a special issue of Deep Sea Research II following editorial and peer review.

We found that the data show the seasonal accumulation of CO2 in colder, denser winter-modified Pacific waters from a variety of mechanisms including terrestrial and marine organic matter respiration over shallow shelves during summer and fall, which are subsequently transported off the shelf. In the Chukchi Sea, most of the offshore flux occurs through Barrow Canyon. We estimate that this outflow delivers ~2.24 Tg C yr-1 of corrosive winter water to the Arctic Ocean. Downstream of Barrow Canyon, moored data records indicate that 0.5 – 1.7 Tg C yr-1 may be returned to the atmosphere via air-sea gas exchange of

CO2 during upwelling events along the Beaufort Sea shelf. This efflux is more than sufficient to eliminate ΩAr undersaturations in the upwelled Pacific halocline waters. However, moored and discrete data records Indicate that potentially corrosive Pacific waters are present in the Beaufort shelfbreak jet during 80% of the year, indicating that other means of carbon accumulation far outweigh any mitigation created by upwelling. Overall, we estimate that these persistent ΩAr undersaturations of the Pacific halocline are a recent phenomenon that appeared between 1975 and 1985. Over that short time, these potentially corrosive waters 70 originating over the continental shelves have been observed as far as the entrances to Amundsen Gulf and M'Clure Strait in the Canadian Arctic Archipelago. The formation and transport of corrosive waters on the Pacific Arctic shelves may have widespread impact on the Arctic biogeochemical system reaching all the way to the North Atlantic.

NOAA relevance/societal benefits

OA exposure is particularly pronounced for two important macroecological environments: the seasonal ice zone in the northern Chukchi Sea, and the advective pathways between the Pacific and the Arctic Oceans. Given the short linkages that characterize the food web in the PAR, OA impacts on important prey species like zooplankton and bivalves emerge in these regions can quickly cause a reduction in food supply for corresponding predators. Despite these vulnerabilities and the exposure to severe, sustained, and widespread acidified conditions in the Pacific Arctic that we found through this synthesis, there is limited evidence that ocean acidification has caused serious population declines or change in the Pacific Arctic ecosystem at the present time. In part, this may be due to natural resilience of the ecosystem.

In order to support commercial industries, coastal communities, and subsistence fishers in the PAR, continued ocean research and monitoring is imperative. As anthropogenic climate change continues to alter the Arctic environment, both vulnerability and resilience of Arctic ecosystems will continue to change. Acidification stress will continue to worsen; even under the most optimistic emissions scenarios for the next several decades, the Chukchi and Beaufort Seas are projected to experience persistent surface layer undersaturations beginning in the next few decades. Even where acidification is not the primary stress on the environment, it does increase the risk of compounding synergistic impacts from other stressors, like warming, hypoxia, and sea ice losses. Many studies predict that the future Arctic will be much different than the one we see today. Evidence-based decision making in the face of these changes has the potential to build adaptive capacity for human communities and prevent potential fishery crashes, like the projected reduction in population and catch of crab in Bristol Bay.

Education

The team involved with this project closely collaborates with the Alaska Ocean Acidification Network (AK-OAN), a group designed to connect scientists and stakeholders together in order to identify critical observing needs and opportunities. During 2016, the AK-OAN and the Alaska Ocean Observing System (AOOS) jointly held a State of the Science workshop, where the work involved in this project was highlighted in a keynote presentation:

Cross, J.N.*, 2016. Ocean acidification in Alaska: OA basics, current monitoring efforts, trends, and areas of highest concern. Alaska Ocean Observing System – Alaska Ocean Acidification Observing Network Open Science Workshop, November, 2016.

Outreach

This project closely contributed to the Global Ocean Acidification Network Arctic workshop, Pathways to Adaptation: Ocean Acidification in the Arctic. The NOAA Ocean Acidification Program, the NOAA Arctic Research Program, the US Department of State, and the Natural Resources Defense Council jointly sponsored this effect to convene socio-economists and inidigenous peoples to begin shaping follow-on OA adaptation strategies that might flow from Arctic Marine Assessment Program case studies. Specifically, this case was highlighted in an invited presentation:

Cross, JN and Mathis, JT. How are GOA-ON activities supporting Arctic adaptation? GOA-ON Arctic Workshop, Helsinki, Finland, October 2016.

A summary for policymakers involved with the Arctic Council is currently being drafted, highlighting the results of this workshop and providing recommendations for regionally focused adaptation strategies.

Publications

Cross, JN, Mathis, JT, Pickart, RS, and Bates, NR, 2017. Formation and transport of corrosive water in the Pacific Arctic Region. Deep-Sea Research II, accepted.

Conference presentations

Cross, JN, and Foy, R. NOAA OAP: US Arctic and Alaska current monitoring efforts, trends, and areas of highest concern. NOAA OAPI Meeting, Seattle, WA, January 2017.

Cross, JN, Mathis, JT, Bates, NR, and Pickart, RS. Formation and transport of corrosive water in the Pacific Arctic Region. Arctic Sciences Summit Week, Prague, CZR, April 2017.

Other products and outcomes

The work in this project was also highlighted as part of the 2016 Arctic Report Card and the Bureau of the American Meteorological Society Annual State of the Climate Report:

J. T. Mathis and J. N. Cross, 'Ocean Acidification,' In: J. Richter-Menge, J. E. Overland, and J. T. Mathis, Eds., 2016: Arctic Report Card 2016, http://www.arctic.noaa.gov/Report-Card.

J. N. Cross and J. T. Mathis, 'Arctic Ocean Acidification,' In: State of the Climate in 2015. *Bull. Amer. Meteor. Soc.,* **97** (8), S1-S275.

AFSC FY 2015 – FY 2017 Alaska Ocean Acidification Research: Autonomous Observations of Ocean Acidification in Alaska Coastal Seas

Jessica N Cross, PI
NOAA Pacific Marine Environmental Laboratory

CIFAR themes: Ecosystem Studies and Forecasting, Climate Change and Variability

Other investigators/professionals associated with this project:
Natalie Monacci, University of Alaska Fairbanks

NOAA Goasl: Healthy Oceans; Climate adaptation and mitigation

Amendment: 51 NOAA Office: OAR, Libby Jewett, Sponsor
Budget Amount: Cumulative $127,440, This year $127,440 (Amendment 51)
This project is new, and it is set to end 02/28/2018.

Primary objectives

This project provides support for ongoing monitoring through the GAKOA surface buoy, a time series site in the central Gulf of Alaska, and the M2 surface buoy (Peggy), a time series site in the southeastern Bering Sea. It also provides support for ongoing subsurface monitoring at the M2 and M8 time series sites in the southeastern Bering Sea.

Research accomplishments/highlights/findings

GAKOA 2016 deployment notes (Gulf of Alaska surface buoy):
Upon turnover of the MAPCO2 surface system at this site in March 2016, seawater CO 2 concentrations showed a sharp drop (50%) during April, coincident with the start of the spring bloom. As compared with older data collected by the Ocean Acidification Research Center at the University of Alaska, this bloom appears to have been starting earlier since the beginning of the data record. The 2016 spring bloom set a record for annual CO2 minimum. However, this drawdown moderated more quickly than in previous years. CO 2 concentrations remained low through May and June, and slowly began to recover to atmospheric levels starting in July.

Peggy 2016 deployment notes (Bering Sea surface buoy):
Upon turnover of the MAPCO2 surface system at this site, seawater CO 2 concentrations were low, showing the drawdown typical of the spring bloom. However, the signal from the surface MAPCO2 system quickly deteriorated, and it is unclear if any of the data collected during the initial few weeks of deployment is actually usable. SAMI pH data was also collected during this deployment. The data quality from this instrument was much higher, indicating some of the first successful pH data return at this site since the start of data collection.

M2 2016 deployment notes (Bering Sea bottom package, 67 m):
For the fall 2016/2017 deployment, a SAMI pCO 2 sensor was deployed alongside a SeaFET pH sensor (Satlantic). The 67 m depth of the sensor package at this site knowingly exceeds the depth rating for the SeaFET, which was revised to 40 m during a previous 67 m deployment by OARC. When exceeding the depth rating, OARC has found that the failure rate of SeaFET sensors is similar to the overall cold-weather

failure rate of the SAMI sensors. These sensors did collect data during the deployments. Data processing and QA/QC is ongoing.

NOAA relevance/societal benefits

Coastal regions around Alaska are experiencing the most rapid onset of ocean acidification (OA) compared to anywhere else in the U.S. Recent research using OA forecast models as well as species and human impact assessments have shown that Alaska coastal communities and the vast fisheries that support them have a varying degree of vulnerability to OA, ranging from moderate to severe (Mathis et al., 2014). The most vulnerable communities rely heavily on the economic and nutritional value of fisheries and other ecosystem services. OA in Alaska also has the potential to have cascading economic impacts well beyond the state level. Because Alaska fisheries provide over $3 billion annually to the U.S. gross domestic product (GDP), even a relatively small decline in one or more of the fisheries in the Gulf of Alaska or Bering Sea could have a very large net economic impact—large enough to dwarf the combined impacts occurring in other U.S. areas.

Partner organizations and collaborators

This project represents a close collaborative relationship between the Pacific Marine Environmental Laboratory and the Ocean Acidification Research Center at the University of Alaska, Fairbanks. These mooring data also contribute to the International Ocean Observing System (IOOS) program and the Global Ocean Acidification Observing Network (GOA-ON).

Impact

The researchers involved with this project also work closely with the Alaska Ocean Acidification Observing Network, an impact-driven group designed to connect scientists to stakeholders. Through that group, these monitoring activities support a number of cross-cutting research efforts. Firstly, the time series provides new insights into the seasonal progression of OA events caused by the progressive accumulation of anthropogenic CO_2 into the region's coastal seas. The mooring data can also be used as an early warning system for stakeholders around the state, as well as to provide information for other types of OA research. Other projects within the OAP Alaska Enterprise focus on laboratory based evaluation of the impact of OA on commercially and ecologically important Alaskan species, especially during the vulnerable larval and juvenile life stages. This environmental monitoring informs those studies by describing the intensity, duration, and extent of OA events and providing a baseline for projecting future conditions. Finally, this observational data is used to validate new OA models that are currently being developed for the Gulf of Alaska and Bering Sea, and are applied in bio-economic models of crab and pollock abundance forecasts.

Publications

Cross, J.N., Mathis, J.T., W. Evans, and N. Monacci. The Physical and Biogeochemical Influences on Ocean Acidification in the Northern Gulf of Alaska, Journal of Geophysical Research, in preparation.

Cheng, W., Cross, J.N., and Mathis, J.T., Future projections of ocean acidification in the Gulf of Alaska from the CCSM4 model. Geophysical Research Letters, in preparation.

Conference presentations

Cross, J.N., Mathis, J.T., Foy, R., Hurst, T., Sigler, M., Dalton, R., Stone, R., 2017. US Arctic and Alaska Ocean Acidification: Current monitoring efforts, trends, and areas of highest concern. NOAA Ocean Acidification Program PI Meeting, Seattle, WA, January 2017.

Cross, J.N., Mathis, J.T., Monacci, N.M., 2017. Ocean acidification in Alaska: Ecosystem and Economies. Alaska State Legislature House Resources Committee, Juneau, AK, February 2017.

Cross, J.N., Mathis, J.T., 2016. Ocean acidification in Alaska: OA basics, current monitoring efforts, trends, and areas of highest concern. Alaska Ocean Observing System Ocean Acidification PI Meeting, Anchorage, AK, November, 2016.

Cross, J.N., Mathis, J.T., 2016. Ocean acidification in Alaska: OA Ecosystems and Economies. NOAA Pacific Marine Environmental Laboratory, Seattle, WA, November 2016.

Cross, J.N., Mathis, J.T., Monacci, N.M., 2016. Ocean Acidification in Alaska: Introduction and Integrated Monitoring. Aleutian Life Forum, Dutch Harbor, AK, May 2016.

Geological substrate and potential habitat map for deep sea corals and sponges in the Gulf of Alaska margin and the Aleutian shelf and slope regions

Jennifer R. Reynolds, PI ***CIFAR theme: Ecosystem Studies and Forecasting***
University of Alaska Fairbanks

Other investigators/professionals associated with this project (w/affiliation):
Agno Rubim de Assis, *UAF summer intern*; **H. Gary Greene**, *Moss Landing Marine Laboratories and SeaDoc Society*; **Chris Rooper**, *NOAA/NMFS AFSC*; **Bob Stone**, *NOAA/NMFS AFSC*; **Peter Etnoyer**, *NOAA/NOS NCCOS Center for Coastal Environmental Health and Biomolecular Research*; **Robert McGuinn**, *NOAA/NOS NCCOS Center for Coastal Environmental Health and Biomolecular Research*; **Enrique Salgado**, *NOAA/NOS NCCOS Center for Coastal Environmental Health and Biomolecular Research*; **Cheryl Morrison**, *USGS Leetown Science Center*; **Rhian Waller**, *University of Maine, Darling Marine Center*; **Keri Feehan**, *University of Maine at Orono (student)*; **Branwen Williams**, *Claremont McKenna College*

NOAA Goal: Healthy Oceans

Amendments: 6, 25 NOAA Office: NMFS-AFSC, Chris Rooper, Sponsor
Budget Amounts: Cumulative $58,367, This year $0
This project is complete.

Primary objectives

The Alaska Deep Sea Coral and Sponge Initiative (AKCSI) was funded by NOAA's Deep Sea Coral Research and Technology Program to better understand the location, distribution, ecosystem role, and status of deep-sea coral and sponge habitats. This CIFAR project addressed the need to characterize and map seafloor habitats, and particularly seafloor substrates, in order to predict distribution of deep sea corals and sponges. Geologists Jennifer Reynolds and Gary Greene, funded separately, collaborated with AKCSI researchers from NOAA and US Geological Survey (USGS) to construct interpreted (from geology) substrate and potential habitat maps for deep-sea corals and sponges in Gulf of Alaska and Aleutian Islands waters.

Research accomplishments/highlights/findings

This research supported two elements of the Alaska Deep Sea Coral and Sponge Initiative.

Red tree coral (Primnoa pacifica) thicket habitats in the eastern Gulf of Alaska. This was a major field program to examine the biology and ecology of red tree corals (*Primnoa pacifica*) at five study areas in the eastern Gulf of Alaska. Red tree corals form dense thickets in some areas of the North Pacific, but their locations are largely unknown. The importance and vulnerability of red tree coral thickets has been recognized by the North Pacific Fishery Management Council and known thickets have been protected through establishment of five Habitat Areas of Particular Concern (HAPCs). Sites for this research were chosen based primarily on coral bycatch in NOAA longline surveys. We collected high-resolution multibeam bathymetry and backscatter data at these sites in 2012, constructed substrate habitat maps, identified targets of interest, and conducted ROV dives at four sites on the shelf and upper slope in 2013 and 2015. Results for each site characterized the occurrence and habitat associations of red tree coral colonies as well as their size and condition. Coral colonies were sampled for genetic and reproductive studies. Other species of deep sea corals and sponges were documented and sampled. The results also confirmed that red tree coral habitat extends significantly beyond the areas of current HAPCs.

Geological substrate mapping and bathymetry and sediment compilations. Substrate maps and habitat interpretations were constructed for the sites mapped in the eastern Gulf of Alaska, as described above, and contributed to systematic exploration and sampling of these sites. New bathymetry and sediment maps for the Aleutian Islands and parts of the Gulf of Alaska were constructed from archived NOAA charting data by project collaborators. The site-specific, high resolution substrate maps provide a basis for interpretation of the broader maps. Future work will expand geological interpretation of these maps and data to provide substrate classifications on a broad scale.

NOAA relevance/societal benefits

The goal of NOAA's exploration and research on deep-sea coral and sponge ecosystems is to provide decision- makers with sound scientific information that will enable effective ecosystem-based management decisions. Research activities in Alaska have provided a better understanding on the location, distribution, ecosystem role, and status of deep-sea coral and sponge habitats.

Deep sea coral and sponge ecosystems are widespread and abundant in the Alaska region, and have unusually high biological diversity. They are associated with many species of fish and invertebrates, including commercially fished species. Current concerns include both ocean acidification and vulnerability to damage from commercial fishing activities. The Alaska Deep Sea Coral and Sponge Initiative (AKCSI) contributes to scientific understanding of the location, distribution, ecosystem role, and status of deep-sea coral and sponge habitats in Alaskan waters. This research has direct implications for fisheries management in the Alaska region, as well as a broader understanding of the marine ecosystems.

Partner organizations and collaborators

NOAA Deep Sea Coral Research & Technology Program (funding)
NOAA/NMFS Alaska Fisheries Science Center: Chris Rooper, Bob Stone
NOAA/NOS/NCCOS Center for Coastal Environmental Health and Biomolecular Research: Peter Etnoyer, Robert McGuinn, Enrique Salgado
USGS Leetown Science Center: Cheryl Morrison
Moss Landing Marine Laboratories and SeaDoc Society: H. Gary Greene
University of Maine at Orono and Darling Marine Center: Rhian Waller, Keri Feehan
Claremont McKenna College, Keck Science Center: Branwen Williams

Education

A UAF summer intern, Agno Rubim de Assis, assisted Reynolds with 2015 cruise operations and with data analysis after the cruise. Mr. Assis was a talented undergraduate student on a scholarship from the Brazilian Scientific Mobility Program of the Brazilian government.

Outreach

NOAA project web page: http://www.afsc.noaa.gov/quarterly/jfm2012/divrptsrace7.htm

Publications

None to report at this time.

Conference presentations

Assis, A.R., Reynolds, J.R, Greene, H.G., Stone, R.P. and Rooper, C.N. (2016): Benthic habitat for *Primnoa* deep-sea coral in the Fairweather Ground, Gulf of Alaska. GeoHab 2016 (Winchester, England), May 2-6, 2016.

Other products and outcomes

Alaska Deep Sea Coral Team (Chris Rooper, Bob Stone, Peter Etnoyer, John V. Olson, Jennifer Reynolds, Gary Greene). *Alaska Deep-Sea Coral and Sponge Initiative: Final Report*, 72 pp. Submitted to the NOAA Deep Sea Coral Research and Technology Program, August 2016.

Literature review of cetacean ship strikes & suggested mitigation measures for use in Glacier Bay National Park

Terrance J. Quinn II
University of Alaska Fairbanks

CIFAR theme:Ecosystem Studies and Forecasting

NOAA Goal: Healthy Oceans

Amendments: 39, 49 NOAA Office: NFMS, Douglas DeMaster, Sponsor
Budget Amounts: Cumulative $47,957, This year $22,957 (Amendment 49)
This project is set to end 06/30/2017.

Primary objectives

The recovery of large whale populations is threatened by lethal interactions with large marine vessels. The International Whaling Commission (IWC) has identified a need to produce a Strategic Plan outlining the direction of ship strike work for the period 2017-2020. The purpose of such a document is to outline areas in which ships and large whales frequently meet ("hot spots"), to identify vulnerable whale populations, to identify worthwhile avoidance technologies in ship/whale encounters, to encourage collaboration in key sectors, and to streamline data collection and communication.

In order to address the issue of ship strikes with large whales, research will be done to provide the scientific basis for this Strategic Plan. Three research objectives are: (1) to review the literature on ship strikes of large whales around the world, (2) to identify areas where ship strikes are more likely (hot spots), and (3) to synthesize this research into a draft of a Strategic Plan that can be used by the IWC Ship Strike Working Group.

Research Accomplishments/highlights

An annotated bibliography on ship strike literature has been compiled and distributed to the IWC Ship Strike Working Group, meeting Objective 1. Research has been conducted on identifying hot spots, meeting Objective 2. The Strategic Plan is in its final round of review and should be posted on the IWC website by June 2017, meeting Objective 3.

NOAA relevance/societal benefits

The project will provide support for NOAA's participation in a Working Group of the International Whaling Commission concerning the impacts of ship strikes on large whale populations. Support will include, but is not limited to, production of a Strategic Plan on the subject, to assist in avoidance technologies in Glacier Bay National Park, and to develop tactics to increase reporting of ship strike events throughout the world. This information will be used to support various positions of the US Government over the next two years. This Plan will be used cooperatively by governments and international organizations to mitigate lethal ship strikes and will be presented at the upcoming meeting of the International Whaling Commission.

Education

Kelly Cates was hired to work on this project as her thesis research in a M.S Fisheries degree program at the University of Alaska Fairbanks. As a result of her research on ship strikes, Kelly has networked with many of the experts in the field. Kelly will meet with her graduate research committee in June for her

annual review. She has previously completed her comprehensive exam and is currently on a Knauss Fellowship.

Outreach

This project accomplishes two major outreach impacts: (1) training of a master's level fisheries graduate student in drafting of strategic reports (2) translating existing knowledge of ship strikes with large whales into research about mitigation efforts to reduce these occurrences.

Publications and presentations

2015 Society of Marine Mammalogy Conference-Poster

2016 Alaska Marine Science Symposium-Poster

2016 AFS Student Symposium-15min Talk

2016 Presentation of SP Outline to IWC working group on ship strikes

2017 Office of Naval Research Review

Other products and outcomes

Ship Strike Strategic Report Annotated Outline for the IWC – April 2016

Ship Strike Strategic Report- In Review April 2017

Partner organizations and collaborators

IWC, NOAA

Doug DeMaster (AKFSC), Robert Brownell (SWFSC), Greg Silber (NMFS), Aleria Jensen (NMFS), Scott Gende (NPS)

Publications related to this project, funded under previous cooperative agreements

None to report at this time.

Innovative Technology for Arctic Exploration

Jessica Cross, PI ***CIFAR theme: Ecosystem Studies and Forecasting***
NOAA Ocean Acidification program

Other investigators/professionals associated with this project:
Natalie Monacci, University of Alaska Fairbanks

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendments: 13, 54 NOAA Office: OAR-PMEL, Chris Sabine, Sponsor
Budget Amounts: Cumulative $155,964, This year $0
This project was set to end 03/31/2017. However, additional funds may be received.

Primary objectives

The goal of this proposal is to quantify the spatial and temporal variability of physical, chemical, and biological properties in the surface layers of the Bering and Chukchi Seas after ice retreat using advanced innovative glider technology.

The objective of this proposal is to conduct wave glider surveys to quantify the spatial and temporal variability of carbonate parameters (pCO_2 and pH) as well as associated biogeochemical measurements (i.e. dissolved oxygen, chlorophyll, etc.). The benefits of this proposal could be enormous and include new partnerships, interdisciplinary discovery and baseline characterization of evolving processes in a poorly understood ocean region.

Research accomplishments/highlights/findings

From FY 15-17, the central goal of this program has been to conduct autonomous vehicle surveys in coastal Alaska in order to assess surface water carbon parameters with high resolution sensors. During FY 15, a survey was conducted in the Chukchi Sea that helped to map the progression of sea-air CO_2 exchange during the summer season, as correlated with other biogeochemical mechanisms. That deployment worked to identify differences in sea-air exchange between various types of surface water, including ice melt. Analysis of the FY 15 deployment continued during this year. One key finding showed that ice melt, even late in the season, could prompt extremely rapid influx of atmospheric CO_2 into the shelf system, despite simultaneous buildup of CO_2 in bottom waters from respiration (Figure 1). This facilitated continued CO_2 influxes through September, later than expected.

During FY16, we made a second deployment of the wave gliders in the Bering Sea during summer and fall. The location of this deployment was based on availability of a ship for the deployment and recovery of the vessels. However, this adjustment proved to be extremely fruitful. Previous ship-based surveys of the coastal Bering Sea have identified high CO_2 concentrations close to shore. While we have speculated on the causes, extent, and duration of these signals in previous work, the wave glider deployment allowed us to further investigate this phenomenon. Firstly, we did confirm the signal again during 2016, indicating that this is likely a persistent feature. pCO_2 values above atmospheric levels first appeared in July, peaked in early August, and moderated through September, somewhat earlier than had been previously hypothesized (Figure 2). These conditions were also well-correlated with lower oxygen concentrations, indicating that the excess CO_2 is likely produced through respiration of organic matter (Figure 3). One last goal of this deployment was to determine whether this organic matter was marine or terrestrial in origin. Unfortunately, the Ecosystem Wave Glider with the instrumentation for this research was not recovered.

NOAA relevance/societal benefits

Extensive physical changes are underway in the Arctic Ocean including a transition from multi-year to seasonal ice, an increase in open water, and changes in water chemistry, particularly ocean acidification (OA) that is largely due to rising atmospheric carbon dioxide (CO_2) levels. However, there are non-CO_2 drivers of OA in the Arctic Ocean that can play a dominant role in determining carbonate mineral saturation states. In conjunction with anthropogenic carbon, sea ice melt, river runoff, upwelling and the retention of respiration products can all drive carbonate mineral undersaturations so that the extent, duration and intensity of OA events can be highly variable both spatially and temporally. It remains unknown how these dramatic changes will impact the marine ecosystem (from microbes to whales) as well as the native communities that rely on marine services for a significant portion of their subsistence diet and cultural identity. Because of the rapid pace of change and the remote and harsh environment of the Arctic, it has proved difficult to obtain adequate information needed to assess ongoing changes in the ecosystem, especially in the technically challenging surface domain of the marginal ice zone. This project uses cutting edge tools to address these challenges.

Partner organizations and collaborators

This project relies closely on collaboration with the Ocean Acidification Research Center at the University of Alaska Fairbanks, the NOAA Arctic Research Program, the Fisheries-Oceanography Coordinated Investigations Program, the NOAA Fisheries Resource Assessment and Conservation Engineering Division, and the Innovative Technology for Arctic Exploration Program. This project leverages ship time from other projects in order to deploy and recover the wave gliders, and ship time availability in the Chukchi Sea was not available during 2016. Secondly, the third deployment will be conducted with a more advanced platform, the ASV-CO_2 Saildrone. The development of this platform is being leveraged through other projects, and will be completed in time for a 2017 deployment. The shift to the new platform was necessitated by the loss of one of the wave gliders used in the Bering Sea during 2016. Lastly, by leveraging other project funding the deployments for this mission have been expanded to 2-3 month missions across three years, rather than a single 30-day mission during one year. This represents a 300% increase in the data generation suggested in the original proposal.

Outreach

Rachel Pryor, NOAA Office of Response and Restoration profiled this project online: https://usresponserestoration.wordpress.com/2016/07/28/remotely-controlled-surfboards-oil-spill-technology-of-the-future/

Publications

Mathis, J.T., and Cross, J.N., 2016. 'Ocean Acidification.' In: Richter-Menge, J., Overland, J.E., and Mathis, J.T., Eds. Arctic Report Card 2016, http://www.arctic.noaa.gov/Report-Card

Conference presentations

Cross, J.N., Carbon Cycling and Ocean Acidification in the Pacific Arctic Region, Fall 2015 Update. Pacific Arctic Group Fall Meeting, Incheon, South Korea, October 2015.

Cross, J.N., Carbon biogeochemistry and ocean acidification in the Bering Sea and Pacific Arctic Region. University of Alaska, Fairbanks School of Fisheries and Ocean Sciences Fisheries Division, Juneau, AK, October 2015.

Cross, J.N., Evans, W., Mordy, C.W., Stabeno, P.J., Mathis, J.T., Bell, S., Salo, S., and Tabisola, H. Integrated analysis of high-resolution autonomous observations in the Pacific Arctic Region. Arctic Observing Open Science Meeting, November 2015.

Mathis, J.T., Cross, J.N., Evans, W., and Doney, S.C. Ocean Acidification in the Pacific-Arctic Boundary Regions. Alaska Marine Science Symposium, Anchorage, AK, January 2016.

Cross, J.N., Ocean Acidification in Alaska: Ecosystems, Economies, and the DBO Advantage, IARPC DBO Collaboration Team, webinar, May, 2016.

Mathis, J.T., Cross, J.N., Evans, W., and Doney, S.C. Ocean Acidification in the Pacific-Arctic Boundary Regions: Ecosystems and Economies. Oceans in a High CO_2 World IV, Hobart, TAS, Australia, May 2016.

Cross, J.N., Integrated Ocean Acidification Monitoring in Coastal Alaska, Aleutian Life Forum, Dutch Harbor, AK, August, 2016.

Barbero, L., Cross, J.N., Salisbury, J. NOAA Monitoring Efforts and Needs. Joint NOAA OAP - DFO Workshop, St. Andrews-By-The-Sea, NB, Canada, September 2016.

Cross, J.N., 2016. Ocean acidification in Alaska: OA basics, current monitoring efforts, trends, and areas of highest concern. Alaska Ocean Observing System – Alaska Ocean Acidification Coastal Observing Network Open Science Workshop, November, 2016.

RUSALCA data management

Russell Hopcroft, PI ***CIFAR theme: Ecosystem Studies and Forecasting***
University of Alaska Fairbanks

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendments 10, 23, 44 NOAA Office: OAR-CPO, Jeremy Mathis, Sponsor
Budget Amounts: Cumulative $396,328, This year $0
This project is set to end 08/31/2017.

Primary objectives

In support of the Russian-American Long-term Census of the Arctic (RUSALCA) research projects, NOAA has provided support to digitally archive data from all disciplines that would then be made available to the public and principal investigators via a web-based interface. Data will come from biological, physical oceanography, geological, meteorological, and possibly sea ice researchers. Subsets of these data will need to be restricted allowing access only by principal investigators for certain periods of time.

The project objectives are:

Data Consolidation - Collection of raw data from principal investigators and the ingestion of this data and associated metadata into a University-National Oceanographic Laboratory System (UNOLS) Rolling Deck to Repository (R2R) compatible data format.

Web Interface - An advanced web interface that allows users to browse existing data sets, search for data based on a fully cross referenced set of metadata selection criteria including graphical geo-location bases search will be created. The ability to restrict access of specific data sets to principal investigators via a web based users logging on a per user basis will be pursued.

Data Distribution - Users browsing datasets need the ability to download "folders" or multiple selected datasets of data with a single download action that does not require installation of software beyond the web browser on the client side. Automated dataset distribution by remote computers with authentication will be a product of this project.

Research accomplishments/highlights/findings

During this period the PI has been primarily involved in hounding several RUSALCA PIs to deposit their data to the workspace. Nutrient datasets are finally secured, fisheries datasets remain delinquent. Work by Axiom has focused primarily on improving web-based data visualizations for the datasets (see last report). A second-generation interface was released with even greater range of visualizations.

NOAA relevance/societal benefits

This project provides the data infrastructure to for PI to share and explore their data, thus examining the potential impacts of climate change in the Pacific–Arctic gateway.

It places RUSALCA data into public domain, as well as distributes it to major data repositories.

Partner organizations and collaborators

Alaska Ocean Observing System (AOOS)

Axiom Consultants

Impact

This project will place this data into the same cyber-infrastructure as the AOOS, part of the national observing network. AOOS is becoming the major repository for many other datasets for the Pacific-Arctic region from agencies, industry and academia.

Outreach

The Alaska Ocean Observing System (AOOS) has developed several outreach and visualization products based upon data collected during the RUSALCA sampling program. These can be accessed from the AOOS website: http://data.aoos.org/maps/search/rusalca.php.

Changes/problems/special reporting requirements

The persistent problem has been getting PIs to put datasets into the workspace, along with appropriate metadata. Deposited data frequently requires substantial reformatting to produce a useable georeferenced data product.

The Stock Varying Assessment Program (SAIP): Time-varying natural mortality: random versus covariate effects

Terrance Quinn II, PI
University of Alaska Fairbanks

CIFAR theme: Ecosystem Studies and Forecasting

NOAA Goal: Healthy Oceans

Amendments: 28, 38
Budget Amounts: Cumulative $183,116, This year $0
This project is set to end 06/30/2017.

NOAA Office: NMFS-AFSC, Peter-John F. Hulson, Sponsor

Primary objectives

As part of the Stock Assessment Improvement Program, our first objective is to determine the circumstances under which time-varying natural mortality, M is estimable in an age-structured assessment model. We hypothesize that the precision of datasets is most important, especially survey data. The second objective is to compare the performance of estimating M with random effects versus using covariates. We hypothesize that using covariates increases precision unless M is misspecified. Thus, this proposal is responsive to two objectives of the Assessment Methods Working Group to conduct "investigations to develop best practices for addressing specific topics in stock assessments" and "investigations of the performance of assessment methods across a range of data availability and quality". Furthermore, this proposal is "oriented to the broadly applicable theme" of the feasibility of estimating natural mortality, a topic that comes up in discussion of almost all stock assessments.

This is a simulation-estimation study in which a true population is created, simulated datasets are generated, and parameters are estimated with an age-structured assessment model. Estimated parameter values are then compared to the values used to simulate the population, which come from existing stock assessments for the respective species. In this way, the precision and accuracy of estimates can be evaluated. This study models populations after Alaska sablefish (Anoplopoma fimbria) and Eastern Bering Sea pollock (Gadus chalcogrammus), both of which are of commercial importance.

The primary comparison being made in this study is between the performance of covariate and random approaches of estimating time-varying M. Covariate approaches incorporate data on an index that trends with natural mortality (i.e. predation, disease, or environmental conditions) while random approaches make additional assumptions about the error structure of the model so that the assumption of constant natural mortality can be relaxed without necessarily including additional data. Within each of these broad categories of approaches, several sub-scenarios are investigated. Within the covariate approach, we investigate the effect that different levels of observation error in the covariate have on the accuracy and precision of estimates. Within the random approach, we test the performance of models that estimate time-varying M using individual random effects and random walks. Estimation model configurations are tested on three scenarios of time-varying M: (1) linear increase, (2) linear decrease, and (3) sinusoidal fluctuation. The performance of a model that attempts to estimate time-varying M in the case where true M is constant is also evaluated. In addition, we evaluate model performance under low and high survey biomass variability and both a 1-to-1 and 2-to-1 ratio of fishing mortality to natural mortality. In testing the performance of different model structures under these various data qualities and states of nature, we attempt to broadly characterize the performance of models that attempt to estimate time-variable M, while keeping the size of the study appropriate for a master's thesis.

Research Accomplishments/highlights

1. We conducted a literature review of the body of existing knowledge relevant to fisheries stock assessment in the treatment of natural mortality.
2. Ganz gained proficiency in R and ADMB software, to be used in project analysis.
3. We chose Gulf of Alaska sablefish and Eastern Bering Sea pollock stock assessments that are used to construct the operating models for this project; these two represent a relatively slow-growing and a fast-growing population, respectively.
4. We obtained code for the Gulf of Alaska sablefish and eastern Bering Sea walleye pollock stock assessments that were used as a starting point for incorporating time-varying natural mortality.
5. We decided on three operating models to be used for the deterministic component of natural mortality M: constant M, a linear increase in M over time, and sinusoidal variation in M over time. These models contain two different levels of stochastic variation. A covariate is constructed following these trends, also with two levels of variation to represent measurement error.
6. Four estimation models are used: stock assessment with (1) M constant and fixed, (2) M constant and estimated, (3) M estimated with random effects, and (4) M estimated with the covariate.
7. Ganz completed a draft of a thesis which contains the findings of this study.

NOAA relevance/societal benefits

The primary benefit for the Stock Assessment Improvement Program (SAIP) is better information about what circumstances allow M to be estimated, particularly across time and age. This study determined that a random effects model was sufficient to estimate time-varying M, when a hierarchical model with penalized likelihood was implemented. A mixed effects model that used an integrated likelihood approach performed poorly in comparison. Covariates make estimating time-varying M possible with high precision and accuracy; efforts should then be increased in the real world to find covariates, such as predator biomass, predator consumption, and disease incidence that are related to M. The Deviance Information Criterion was found to be a useful metric for comparing models.

Education

Quinn hired graduate student Philip Ganz to work on this project for his M.S Fisheries degree. Graduate student Alex Fejer entered the program in Fall 2016 to work on a thesis examining estimability of M for Prince William Sound herring, but funding was not found for him after one semester. Still, some work was accomplished in developing a covariate involving estimation of humpback whale abundance using mark-recapture methods.

In November 2014, Quinn and Ganz attended a conference held by the Center for the Advancement of Population Assessment Methodology on growth modeling, which also provided state-of-the-art information on stock assessment modeling and the treatment of natural mortality.

In January 2016, Quinn and Ganz gave presentations each at two workshops in Chile.

Outreach

Ganz P.D. Quantifying Death: A Love Story. 2015. Presentation for the general public as part of FISH 692: Communicating Science. Juneau, AK. 25 April 2015.

Publications and presentations

Publications

Ganz, P.D. 2017. Estimability of time-varying natural mortality in groundfishes: covariates and hierarchical models. M.S. Thesis, University of Alaska Fairbanks, Fairbanks AK. (first draft)

Presentations

Ganz, P.D. and T.J. Quinn II. 2015. Estimability of time-varying natural mortality in exploited groundfishes. Alaska Chapter of the American Fisheries Society Student Symposium. Juneau, AK. 3 April 2015.

Ganz, P.D., T.J. Quinn II, P.J.F Hulson and D.H. Hanselman. 2015. Estimability of Time-Varying Natural Mortality in Gulf of Alaska Sablefish with a Simulated Covariate. American Fisheries Society National Meeting. Portland, OR. 16-20 August 2015.

Ganz, P.D., T.J. Quinn II and P.J.F Hulson. 2016. The Mathematics of Mortality: How Do We Model Death in Fish Populations? Valparaiso's Math and its Applications Days. Valparaiso, Chile. 7-8 January 2016.

Ganz, P.D., T.J. Quinn II and P.J.F Hulson. 2016. Time of Death: Modeling Time-varying Natural Mortality in Fish Populations. Jornadas de Modelamiento Matemático para la Toma de Decisiones en Evaluación y Gestión Pesquera. Valparaiso, Chile. 18-20 January 2016.

Ganz, P.D. 2017. What the heck are random effects? American Fisheries Society Alaska Chapter, Annual Meeting, March 21, 2017.

Quinn, T.J., II. 2016. Contemporary Models in Fish Population Dynamics. Valparaiso's Math and its Applications Days. Valparaiso, Chile. 7-8 January 2016.

Quinn, T.J., II. 2016. Contemporary Models in Fish Population Dynamics and Their Application to Fisheries Management. Jornadas de Modelamiento Matemático para la Toma de Decisiones en Evaluación y Gestión Pesquera. Valparaiso, Chile. 18-20 January 2016.

Quinn, T.J., II. 2016. Contemporary Models in Fish Population Dynamics and Their Application to Fisheries Management. Instituto de Investigación Pesquera (INPESCA), Concepción, Chile. 18-20 January 2016.

Quinn, T.J., II. 2016. Contemporary Models in Fish Population Dynamics and Their Application to Fisheries Management. Seminario Departamento De Matemática, Universidad Técnica Federico Santa María, Sala de Seminarios, Edificio F, UTFSM, Valparaiso, Chile. 17 March 2016.

Quinn, T.J., II. 2016. Mathematical, statistical and computational modeling of fish population dynamics remains the core of fisheries stock assessment and management. World Fisheries Congress, Busan, Korea. 24 May 2016.

CIFAR Project: Support to Convene the 2016 Arctic Science Summit Week (ASSW) and Arctic Observing Summit (AOS) at the University of Alaska Fairbanks

Hajo Eicken, PI
Scott Rupp, Co-PI
University of Alaska Fairbanks

CIFAR Themes: Ecosystem Studies and Forecasting and Climate Change and Variability

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendment: 45
Budget Amount: Cumulative $100,000, This year $0
This project is complete.

NOAA Office: NOS, NESDIS, and OAR, Jeremy Mathis, Sponsor

Primary objectives:

To convene the 2016 Arctic Science Summit Week (ASSW) and Arctic Observing Summit (AOS) at the University of Alaska Fairbanks in March 9-20, 2016.

ASSW is an annual gathering of international organizations engaged in supporting and facilitating Arctic research that is designed to strengthen collaborations across academia, government agencies, local communities, industry, non-governmental organizations, and other Arctic stakeholders. ASSW 2016 (http://assw2016.org/) was held in conjunction with the AOS (http://www.arcticobservingsummit.org/), the Arctic Council Senior Arctic Officials (SAO) Meeting, the International Arctic Assembly, and other local events and side meetings. The AOS is an international, biennial forum of scientists, agencies, Indigenous Peoples' organizations, Arctic community members and the private sector. The goal of the AOS is to coordinate the design, development and implementation of an international, comprehensive and sustained pan-Arctic observing system. The development and planning of the AOS is led by the International Study of Arctic Change (ISAC) in partnership with the Sustained Arctic Observing Networks (SAON) initiative and local organizers. The AOS is an outreach event of SAON, which is co-led by the Arctic Council via the Arctic Monitoring and Assessment Programme (AMAP) and the International Arctic Science Committee (IASC).

Research Accomplishments/highlights

Funds from this NOAA grant supported activities associated with convening the 2016 Arctic Science Summit Week (ASSW) and Arctic Observing Summit (AOS) hosted by the University of Alaska Fairbanks in March 9-18, 2016.

ASSW 2016 was unique in that several significant meetings were held concurrently, including the International Arctic Assembly, the third biennial Arctic Observing Summit, the first Model Arctic Council, and the Arctic Council's Senior Arctic Officials meeting. The week was rounded out with over 150 additional open and closed side meetings, cultural events, media briefings, field trips, tours and several public outreach events. Approximately 1000 conference participants from 30 countries descended on Fairbanks over the ten-day period of March 9-20, 2016, and 2000 unique views were documented when people around the world joined the live web-stream. Over 1000 people—many from the UAF and Fairbanks community—participated in the public outreach events. The full program of ASSW events is available for download online (http://assw2016.org/img/20160309_ASSWprogram_web.pdf).

NOAA relevance/societal benefits

ASSW 2016 had a diverse primary audience, which included: Arctic research organizations and scientists; state and federal program managers (NOAA, NASA, etc.); private sector; federal officials and bureaucrats; NGO's and nonprofits; Arctic indigenous community members and leaders; and legislators and policy makers. Secondary audiences included the greater University of Alaska Fairbanks campus, Fairbanks and other Alaska communities, members of the media and press, and virtual participants.

Arctic Observing Summit

Many of the plenary, and thematic working group (www.arcticobservingsummit.org/aos-2016-theme-descriptions) and cross-theme discussions at the AOS aligned with NOAA's Arctic Vision and Strategy Goals (Fig. 1).

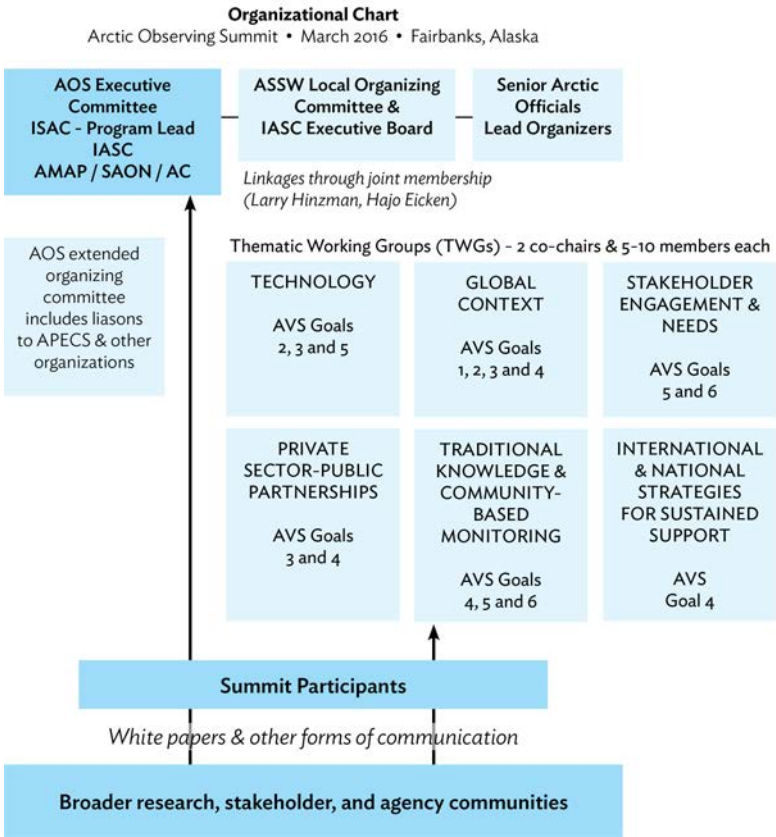


Figure 1. Schematic overview of AOS 2016 activities, organizational structure and ties to Arctic Council (AC) and other entities. NOAA Arctic Vision and Strategy (AVS) Goals addressed are indicated.

Over 450 delegates from 25 or more countries met through a series of plenary presentations, thematic working group and cross-theme discussions, and poster presentations to discuss and develop recommendations and an implementation plan for an internationally supported, pan-Arctic observing system that incorporates a diversity of needs at local-, regional-, and global- levels. The following seven major recommendations (www.arcticobservingsummit.org/aos-2016-conference-statement-0) emerged from the 2016 AOS:

1. **Develop** international principles and protocols that establish ethical guidelines for research, for the involvement of Arctic Indigenous Knowledge holders, for the use of Indigenous Knowledge and the co-production of knowledge. Develop mechanisms to enable collaborative approaches and building of trust among partners, such as researchers, Indigenous Peoples, private sector entities and others, to define observational needs, and to plan, prioritize, implement, and use sustained observations.
2. **Propose** to the highest levels of government, the business case for a comprehensive pan-Arctic observing system. This proposal should assess the costs and demonstrate the benefits for society at various levels, including an Implementation Plan that builds upon the present system and past planning, and that identifies needed resources including infrastructure, instrumentation, human capacity, the pathways to financing, and a strategy for sustained financing.
3. **Create** opportunities for stakeholder engagement as a critical component of an effective pan-Arctic observing system that includes strategies for improved communication, takes advantage of existing natural capital, creates avenues for research collaboration, identifies resources for capacity building and participation of local and Indigenous knowledge holders, and resolve jurisdictional, regulation and policy hindrances to active participation.
4. **Coordinate** the implementation of a pan-Arctic observing system with regional and global observing initiatives, and organize efforts in securing resources for its sustained operation through the leadership of the SAON initiative.
5. **Advance** a strategy for international funding, ideally with a single application and review process and contributions of resources from all partner countries, along with established national support mechanisms. Full implementation of a pan-Arctic Observing System requires coordination of funding efforts to support a globally connected and internationally accessible network.
6. **Prioritize**, on an ongoing basis, observations that should be started and maintained over the long-term by operational and other relevant agencies. Collaborative, sustained observations need to be implemented through a combined research-operational system that extends across all scales relevant to those it serves, making use of both long-term national/institutional funding and of project based competitive funding.
7. **Work**, through the IASC-SAON Arctic Data Committee, to develop a broad, globally connected Arctic observing data and information system of systems that is based on open access data and standards, in addition to recognizing and addressing ethical use and proprietary rights of Indigenous Knowledge and that delivers value to Arctic and global communities.

Education

Not applicable.

Outreach

The Local Organizing Committee planned and organized numerous thematic events that created opportunities for conference participants to network, and local and state representatives to become involved in Arctic issues.

<u>Community Events</u>

1) Dark Winter Nights: North Through Our Eyes

Location: Pioneer Park, 2300 Airport Way

Dark Winter Nights: North Through Our Eyes (Fig. 2) was an evening of storytelling was produced with the Dark Winter Nights team and supported by the Alaska Center for Climate Assessment and Policy. Admission was free.

Figure 2. Community event, Dark Winter Nights: North Through Our Eyes.

2) Arctic Cinema & Science Film Festival

The Department of Theatre and Film from the UAF College of Liberal Arts invites you to the Salisbury Theatre for an evening of films celebrating the Arctic and science! Free admission.

Organizers of this event collaborated with the K-12 Art and Film competition to decide which films would rank 1st through 4th for a monetary prize. Organizers also worked with the Dena film Celebration at Festival of Native Arts and the Anchorage International film Festival. By doing this, event coordinators were able to pool resources and share costs of the event, such as sharing a printed program.

3) Art Show: Arctic Perspectives

Location: Fine Arts Complex / UAF Art Gallery

Art inspired by the Arctic and research to improve Arctic understanding was showcased in this public art-science event (Fig. 3). Contributors included researchers and artists from the University of Alaska Fairbanks as well as members of the community.

Figure 3. Community event, Art Show: Arctic Perspectives was a public art-science collaborative event.

4) Visualizing the Relationships that Shape our Work

Location: Bunnell Building UAF/Schaible Auditorium

A panel and reception was held in loving memory of Archana Bali, celebrating "Voices of the Caribou People Project" and our shared interest in visual research." The session included films, film segments and panel discussions on the intersection of art, science, and visual research. Free admission.

5) Family Game Night

Location: Great Hall in the UAF Fine Arts Complex

An evening of Arctic-themed games and activities for the whole family.

Estimated number of participants: 75, included families with children (majority), some groups of adults, and some ASSW participants.

Total number of Volunteers: 25; one of the volunteers traveled from New York (Columbia University) and another traveled from Anchorage (member of the Cook Inlet Tribal Council); Four Alaska Native women (3 local teachers and the other, director of the Association of Interior Native Educators) were among the volunteers.

The Family Game Night and ASSW were featured in a posting at the Glacier Hub by Ben Orlove (who is also part of the PoLAR Climate Change Education Partnership). http://glacierhub.org/2016/03/24/at-family-game-night-glacier-retreat-is-in-the-cards/.

The following games and activities were used by children and their parents during the Family Game Night:

-Ecochains: Arctic Crisis - a fun and easy-to-learn card game for all ages. In this 2-4 player game of strategy and survival, players build an Arctic marine food web, learn about the importance of sea ice, and see the potential impact of future changes on the ecosystem. Developed by the Polar Learning and Responding (PoLAR) Climate Change Education Partnership.

-Game of Neqpik (Neqpik means fish or food) - a cooperative board game that illustrates the complex flow of resources and relationships that characterize the mixed cash and subsistence economies in many rural Alaskan communities. Players experience scenarios and make decisions as they gain insight on how cash, natural resources, and goodwill contribute to people's livelihoods and well-being in a rural Yup'ik community on the Yukon River. Developed by the UAF Fish to School program.

-**Climate Change and Permafrost Tipping Point Jenga** - these games are a spinoff of the game 'Jenga' and were developed by a UAF permafrost research and education outreach project.

-Arctic and Sea Ice Extent Puzzles – Images illustrated changes in landscapes over time and sea loss over time. Developed by the PoLAR Climate Change Education Partnership.

Paired with the Arctic puzzle, there was an activity where children could decorate styrofoam cups that will be sent to deep ocean depths together with some scientific instruments, on one of the Sikuliaq (a Univ. of Alaska ocean research vessel) expeditions. Following the expedition, the cups will be returned to the students. This activity was Alice Orlich's idea, which she has done in other outreach events with K-12 students.

-**GeoData Center Game** - Glaciers Then and Now

-Video Game - *Never Alone* produced by the Cook Inlet Tribal Council members

-**iPad Game** - *Arctic UAV*

-**Coloring Pictures –** pictures of Arctic birds and animals were available for coloring. The pictures were provided by the Fairbanks Fish and Wildlife Field Office

-**Arctic Wildlife Diorama** – pictures were available that could be cut and glued together to form a diorama. Material were provided by the Fairbanks Fish and Wildlife Field Office.

6) Healing and Wellness: Addressing Historical Trauma through Indigenous Knowledge and Practices

Healing and Wellness (Fig. 4) was a two-part community event. Panelists were first provided an overview of Indigenous peoples in Alaska, including information regarding the history of colonization and its generational, traumatic impacts. The second part of the panel included presentations of community-based research that focused on translating and implementing traditional knowledge into practices that increase resilience and contribute to healing among Alaska Native people, families and communities. A question and answer period followed.

Panelists: Stacy Rasmus, Center for Alaska Native Health Research; Vice Chancellor Evon Peter, UAF College of Rural Development (CRCD); Judy Ramos, Assistant Professor, UAF Department of Alaska Native Studies & Rural Development; and Jessica Black, Assistant Professor CRCD.

Figure 4. Community event, Healing and Wellness: Addressing Historical Trauma through Indigenous Knowledge and Practices (Photo courtesy Alaska Village Voices).

7) Coastal bathtub rings: What ancient shorelines tell us about future sea level rise -- A Science for Alaska Lecture with Julie Brigham-Grette

Location: Wedgewood Resort, 212 Wedgewood Dr

Science for Alaska is one of the largest public outreach efforts undertaken each year by the Geophysical Institute at the University of Alaska Fairbanks. The series brings current scientific research to communities throughout the state on topics as diverse as alternative energy to walruses.

This Science for Alaska lecture was presented by renowned Arctic scientist Julie Brigham-Grette from the University of Massachusetts-Amherst. Brigham-Grette is an expert in climate evolution and sea-level history in the Arctic over the last 3.6 million years. She is the chief United States scientist for the International Lake El'gygytgyn Drilling Project, which has collected one of the longest core samples of sediments ever found in the Arctic. Brigham-Grette recently began a three-year term as the chairwoman of the U.S. National Academy of Sciences' Polar Research Board.

About the presentation: Glacial and interglacial change during the ice ages uniquely imposed on the Bering Strait region some of the most radical changes in sea level and paleogeography documented in the Northern Hemisphere. The Bering Land Bridge is a landscape that existed because of glaciation, exposing the shallow parts of the Bering and Chukchi seas. Following the transition from a forested Arctic 3 million years ago to the first major glaciation of the northern hemisphere about 2.6 million years ago, coastal marine deposits found along the coasts of Alaska and Chukotka record a number of critical transitions in the evolution of Northern Hemisphere climate.

Ancient shorelines, or bathrub rings, record not only natural global warming but also the northward migration of marine ecosystems and changes in the extent of sea ice along Alaska's shores. Changes in Beringian shorelines likely influenced the migration of man into North America. New research helps us understand the rate and timing of the last submergence of the Bering Strait, 12,000 years ago, and how ongoing sea level rise will likely cause changes in the shorelines we live along today.

Student Activities

8) K-12 art & video competition

Pablo Picasso said that every child is an artist, not yet conditioned to be afraid of expressing the world as she sees it. In that spirit, the organizers of the 2016 Arctic Science Summit Week have made space for art installations, including the K-12 art and video contest "Many Lands, One Arctic." The contest was open for submissions from children anywhere in the world.

"We wanted to find a way to engage students and teachers," said Lena Krutikov, a climate science analyst with UAF's International Arctic Research Center and the contest's organizer. "We wanted a way for students' voices to be heard, and give them a creative way to do so."

The theme inspired students from Alaska communities and beyond to submit more than 130 artworks and 13 videos. The artwork came from places like Fairbanks, Anchorage and Anchor Point, as well as Juneau, Selawik, Soldotna and Thorne Bay. Submissions were received from our Arctic neighbors in Norway and Russia, and even decidedly non-Arctic places like Phoenix, AZ and the Bronx, NY.

University of Alaska Museum of the North educator Gabrielle Vance, one of the organizers of the contest, said it was a diverse and impressive body of work. "One emergent theme was concern for environmental change. Several pieces explored Arctic degradation in the form of lonely polar bears, oil spills and diminishing sea ice."

The student artists were particularly fascinated by Arctic animals, such as caribou, fish, foxes, reindeer and whales. Even the narwhal, Vance's personal favorite, made an appearance. By making artwork, Vance said children can explore different definitions of the Arctic, as well as some of its dualities -- unity and diversity, land and sea.

Vance said several of the entries included maps and facts about Arctic biodiversity. “Art and science both involve creativity, collaboration and problem-solving, all of which are especially important in an Arctic environment.”

Selected artwork from the “Many Lands, One Arctic” contest was on display March 11-20 in Arctic Java, the coffee shop located in the Wood Center on the UAF campus. Many of the pieces, both video and artwork, were also on display at the UAF Museum of the North during Family Day: Arctic Science on Saturday, 12 March, 2016.

9) Model Arctic Council

The Model Arctic Council began immediately following the Arctic Council’s Senior Arctic Officials meeting. This was the first international meeting that the Model Arctic Council has initiated. The council members were designated to working groups tasked with working on projects, such as reducing suicide in indigenous groups. The participants presented their solutions to the Arctic Council Senior Officials, University of Alaska Fairbanks administrators, and UArctic leaders.

Sixty-five students participated in the Model Arctic Council (Fig. 5). They represented 13 countries (birth countries). Sixteen were UAF and UAA students. Of the 11 UAF students, one was from Russia, one from China and one from Nunavut. Of the 10 other participants from US universities, one was from New Zealand and one was from Russia.

Figure 5. Model Arctic Council members at the 2016 Arctic Science Summit Week.

Further demongraphic information: Five Russian universities were represented (9 students coming from Russia), and 12 Canadian universities represented (19 students coming from Canadian universities). Smaller numbers of students came from Iceland (5), Greenland (1), Norway (1), Denmark (1), Sweden (2), the UK (1), and Australia (1).

<u>Tours and Excursions</u>

10) Ocean Acidification Open House

Location: UAF campus

The Ocean Acidification Open House was held on the UAF campus on March 16, 2016. There were a total of 35 participants with ⅓ being local and ⅔ being ASSW participants. There was some interesting dialogue with visitors, with some having the potential to lead to future prospects.

11) OneTree Project: A Year in the Life of a Birch Tree

Location: UAF Lola Tilly Commons

OneTree Alaska is a K-12 teacher-scientist partnership that uses Alaska white birch as the jumping-off point for active learning. During this public event, OneTree teachers, students, university researchers, artists, and community members shared their work, which included measuring the effects of LED light treatments on seedling growth, observing budburst on seedlings overwintered in different dormancy environments, using innovations from the maple industry to improve backyard birch syrup-making, and more. This event was hands-on and appropriate for people of all ages, and included pinning a label with your birth year and birthplace on the cross-section of an 80-year old spruce tree from Creamer's Field Migratory Waterfowl Refuge to create a lasting visual representation of the community gathered for Arctic Science Summit Week.

12) Sneak Peek: UAF's Decision Theater North

Location: UAF West Ridge Research Building

Pre-launch of Alaska NSF EPSCoR's Decision Theater North facility as part of Arctic Science Summit Week. This immersive data visualization space features seven 4K resolution screens and a full videoconferencing suite that uses UAF's computing and networking power to visualize data and research products to solve complex real-world problems. This open house showcased the facility's present and future potential for data visualization and decision support for researchers, community members, and industry partners.

13) University of Alaska Museum of the North Events

Location: UAF Museum of the North

Family Programs (Early Explorers and Junior Curators) had mostly local participants, while Family Day had a mix of conference and local participants.

14) Geophysical Institute Tour

Location: UAF Elvey Building

Participants had the opportunity to visit the world-renowned Geophysical Institute. Tours included the Alaska Earthquake Center, Alaska Volcano Center, Alaska Satellite Facility, and more. No reservations required.

15) Poker Flat Research Range Tour

Location: Off Campus

Located approximately 30 miles north of Fairbanks on the Steese Highway, Poker Flat is the world's only scientific rocket launching facility owned by a university. It's operated by the UAF Geophysical Institute under contract to NASA's Wallops Flight Facility, which is part of the Goddard Space Flight Center.

In addition to launching sounding rockets, Poker Flat is home to many scientific instruments designed to study the arctic atmosphere and ionosphere.

Participants were given an opportunity to schedule a tour.

16) Arctic Remote Energy Networks Academy (ARENA) Forum

Location: UAF Lola Tilly Commons

A project of the Arctic Council's Sustainable Development Working Group, ARENA addresses the need for affordable, reliable, and renewably sourced energy solutions for communities that are located in more remote areas of the Arctic. It integrates web-based seminars with classroom learning, field experience, and draws from best practices established through the experience of the people living in the Arctic. Participants will bring back to their home countries knowledge, skills, tools, and a network of collaborators that will facilitate integrating clean energy technologies into their communities, and help improve the management of fossil fuel resources used for power production and heating. A multi-week pilot program is planned for the summer of 2016.

The University of Alaska Fairbanks' Alaska Center for Energy and Power will host a forum about this pilot program. Participants will learn what a microgrid is, the issues encountered when integrating renewable resources, and tour a fully operational microgrid laboratory on the UAF campus.

17) Energy Technology Facility Tour

Location: UAF Energy Technology Facility

ACEP's facilities are designed to offer a testing environment to technology developers. Envisioned as an intermediate step to full commercial deployment, these test facilities have been carefully designed to be easily reconfigured for a range of testing needs, thus permitting assessment of product performance based on many real world conditions. Tours were available to interested participants.

Publications and presentations

No peer-reviewed publications resulted directly from convening the ASSW and AOS conference.

Other products and outcomes

Publications

Wolken, J.M., Lee, O., and Ibarguchi, G. 2016. The 2016 Arctic Observing Summit – the process and path forward. Northern Notes, 45:16-17.

Video presentations

Some media briefings and conference sessions were live streamed online. The following archived videos are available on the ASSW 2016 website (http://assw2016.org/):

11. International Arctic Assembly Part 1 **(morning) and** Part 2 **(afternoon)**
12. Arctic Observing Summit **Plenary Sessions** A & B**, session** C**, session** D**, sessions** E, F & G

Media briefings:

13. Ambassador David Balton
14. Climate and Arctic sub arctic oceans
15. Climate change and adaptation
16. Degrading ice wedges reshape Arctic landscape
17. How the Arctic affects the rest of the world
18. Trans Alaska pipeline and Alaska oil + gas
19. Winter 2015-2016 in context

ASSW 2016 in the News

The following ASSW 2016 news links are also available on the ASSW website:

20. **14 April:** IASC Progress Edition ASSW 2016 published (newsletter) | **International Arctic Science Committee**
21. **8 April:** Togiak man participates in ambassador program | **Bristol Bay Times**
22. **7 April:** Arctic Observing Summit Three is concluded | **Alaksa Noosphere**
23. **5 April:** Science summit a rousing success | **Fairbanks Daily News-Miner**
24. **28 March:** ICC supports call for pan-Arctic climate change monitoring system | **Nunatsiaq News**
25. **24 March:** At Family Game Night, Glacier Retreat is in the Cards | **Ben Orlove, Glacier Hub**
26. **21 March:** Climate change, health top Arctic Council meeting in Alaska | **Nunatsiaq News**
27. **18 March:** Alaska Science Forum: Broken ice causes the worst spring breakup floods | **Ned Rozell**
28. **18 March:** Finding a holistic approach to Arctic housing issues | **Shady Grove Oliver, The Arctic Sounder**
29. **18 March:** At Arctic summit, climate change is inevitable and irreversible | **Matt Miller, KTOO**
30. **18 March:** Scientist: Arctic warmth setting up conditions for new low-ice record | **Yereth Rosen, Alaska Dispatch**
31. **17 March:** Arctic Council arrives in Fairbanks | **Matt Miller, KTOO**
32. **17 March:** Scientists, policymakers converge in Fairbanks for Arctic Science Summit Week | **Matt Miller, KTOO**
33. **17 March:** Research vessel anchored for a whole year in the Arctic | **EFE**
34. **17 March:** Scientists: Climate change is behind Arctic's 'startling' winter warmth | **Yereth Rosen, Alaska Dispatch News**
35. **17 March:** Arctic research vessel to spend entire year studying sea ice decline | **Suzanne Goldenberg, The Guardian**
36. **17 March:** Scientists: Climate change is behind Arctic's 'startling' winter warmth | **Yereth Rosen, Alaska Dispatch**
37. **16 March:** Arctic Science Committee to Move to Akureyri | **Vala Hafstad, Iceland Review**
38. **16 March:** In this tiny Arctic town, dramatic warmth threatens everything | **Ryan Schuessler, The Washington Post**
39. **16 March:** Arctic policy decisions must be 'based on facts' | **Robin Wood, Fairbanks Daily News Miner**
40. **15 March:** Drones becoming more popular in the Arctic | **Tim Ellis, KUAC**
41. **15 March:** Record-breaking temperatures 'have robbed the Arctic of its winter' | **Suzanne Goldenberg, The Guardian**

42. **15 March:** Scientists, officials, researchers gather in Fairbanks for Arctic Science Summit Week | **Weston Morrow, Fairbanks Daily News Miner**
43. **15 March:** Newfound interest in Arctic may mean more crowded council meetings | **Yereth Rosen, Alaska Dispatch News**
44. **15 March:** International Guests to Dine In Fairbanks | **KTVF 11**
45. **14 March:** Leaders, scientists attend Arctic summit in Fairbanks | **KTVA**
46. **14 March:** 1,000 converge in Fairbanks for Arctic events | **Alaska Dispatch News**
47. **13 March:** Commentary: Alaskans use Arctic Science Summit Week to focus on climate change | **Tristan Glowa**
48. **11 March:** Showcasing polar research: Arctic Science Summit Week brings international spotlight to UAF | **Fairbanks Daily News Miner Opinion**
49. **11 March:** First U.S. Arctic Science Summit Week Seeks to Share Data, Fill 'Gaps' in Circumpolar Research | **Tim Ellis, KUAC**
50. **11 March:** Arctic science, policy, housing in focus at Fairbanks forums | **Shady Grove Oliver**
51. **10 March:** Arctic Science Summit Week includes number of entertainment, art, family options for Fairbanks | **Fairbanks Daily News Miner**
52. **9 March:** Scientists, Policymakers Converge in Fairbanks for first U.S. Arctic Science Summit Week | **Tim Ellis, KUAC**
53. **9 March:** Arctic science summit gets underway at UAF | **Tim Ellis, KUAC**
54. **8 March:** Upcoming summit in Fairbanks will cover Arctic issues | **KTVA CBS 11 News**
55. **1 March:** Involving industry in sustaining Arctic observations | **World Ocean Council**
56. **28 February:** Museum of the North hosting Arctic Summit programs | **Fairbanks Daily News Miner**
57. **18 February:** Research priorities for the Arctic have been defined | **Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research**
58. **18 February:** Featured Conference: Arctic Science Summit Week and Arctic Observing Summit | **EU-PolarNet**
59. **12 February:** Collegians From Circumpolar Nations to Hold First Model Arctic Council Meeting at UAF | **Tim Ellis, KUAC**
60. **18 December:** Collaboration at heart of Arctic research initiative | **The Arctic Sounder**
61. **29 October:** Understanding the Arctic environment | **Adjacent Government**
62. **9 October:** UAF summit will unite Arctic leaders, Alaskans | **Fairbanks Daily News Miner (Opinion)**
63. **6 October:** My Turn: UAF to host Arctic summit in | **Juneau Empire (Opinion)**
64. **23 September:** UAF to Host Arctic Meeting | **KUAC**
65. **10 June:** UA Fairbanks leading way on Arctic research | **Alaska Journal of Commerce**

Other products and outcomes

UAF Arctic Journalism Fellowship

In an effort to expand public awareness of the Arctic, the UAF Arctic Journalism Fellowship enabled eight journalists to travel to Fairbanks to attend the 2016 ASSW. This fellowships offered established journalists access to Arctic researchers and policymakers, and provided opportunities for them to pursue stories that they might not otherwise have had the opportunity to report on. Many thanks to Alaska Airlines (https://www.alaskaair.com/) for helping make this possible.

News Stories by Journalism Fellows:

66. **22 July:** FAA to Pilots: Do Not Disturb the Whales **- Gloria Dickie, NewsDeeply**
67. **23 May:** The Measure of a Fog: Carbon **- Ian Cheney, Undark**
68. **3 May:** A new tipping point for the disappearing Arctic **- Gloria Dickie, Hakai Magazine**
69. **6 April:** Peer inside the Alaska Permafrost Tunnel that Doubles as a Science Lab **- Gloria Dickie, Motherboard**
70. **2 April:** Scientists plan to freeze a ship into the Arctic icepack **- Zoe Schlanger, Newsweek**
71. **29 March:** Indigenous Cooperation a Model for Walrus Conservation **- Ryan Schuessler, Hakai Magazine**
72. **24 March:** "There was just no snow": climate change puts Iditarod future in doubt **- Suzanne Goldenberg, the Guardian**
73. **19 March:** The odyssey of the first displaced climate change **(Spanish) - Caty Arevalo, EFE VERDE**
74. **17 March:** Arctic research vessel to spend entire year studying sea ice decline **- Suzanne Goldenberg, the Guardian**
75. **16 March:** A ship anchored spend a year at the North Pole to study Arctic ice **(Spanish) - Caty Arevalo, EFE VERDE**
76. **16 March:** In this tiny town, dramatic warmth threatens everything **- Ryan Schuessler, The Washington Post**
77. **15 March:** Record-breaking temperatures have "robbed the Arctic of its winter" **- Suzanne Goldenberg, the Guardian**

Partner organizations and collaborators

The following partner organizations helped fund ASSW 2016:

	18) Partner/Collaborator
Ice Partners $100, 000+	• **National Oceanic and Atmospheric Administration** • **US Department of Energy**
Platinum Partners $50, 000+	**1. National Aeronautics and Space Administration** **2. National Science Foundation**
Gold Partners $25, 000+	**19) North Slope Science Initiative**
Silver Partners $10, 000+	**1. Alaska EPSCoR** **2. Alaska Ocean Observing System** **3. North Pacific Research Board** **4. US Arctic Research Commission**
Institutional Support	**1. Alaska Airlines** **2. Alaska Arctic Council Host Committee** **3. Alaska Center for Climate Assessment and Policy**

	4. Alaska Climate Science Center **5. Fairbanks Daily News-Miner** **6. International Arctic Research Center** **7. International Arctic Science Committee** **8. International Study of Arctic Change** **9. Sustaining Arctic Observing Networks** **10. University of Alaska Anchorage** **11. University of Alaska Fairbanks** **12. UAF College of Liberal Arts** **13. UAF Facilities Services** **14. UAF Geophysical Institute** **15. UAF Marketing & Communications** **16. UAF Office of Information Technology** **17. UAF Scenarios Network for Alaska & Arctic Planning** **18. University of Alaska Museum of the North**

ASSW 2016 hosted more than 50 side meetings, which included the following organizations:

European Polar Board (EPB)
Polar Research Board Spring Meeting
US Arctic Research Commission (USARC)
Alaska Arctic Policy Commission
Asian Forum for Polar Science (AFOPS)
AOOS Spring Board Meeting (Alaska Ocean Observing System)
AMAP/EU-PolarNet Stakeholder Workshop on Arctic Health and Wellness Research Needs (Arctic Monitoring & Assessment Program (AMAP) and EU-Polar-Net)
Interagency Arctic Research Policy Committee (IARPC)
Korean Polar Institute (KOPRI)
Sustaining Arctic Observing Networks (SAON)
Advancing cross-cutting practices for Arctic Flux observations (Cooperative Institute for Research in Environmental Science (CIRES))
International Science Initiative in the Russian Arctic (ISIRA)
Union of Concerned Scientists

Publications related to this project, funded under previous cooperative agreements

Not applicable.

Bering Sea NPZ model development and collaboration

Georgina Gibson, PI ***CIFAR theme: Ecosystem Studies and Forecasting***
University of Alaska Fairbanks

Other investigators/professionals associated with this project:
Kelly Kearney, NOAA, AFSC

NOAA Goal: Healthy Oceans

Amendment: 57 NOAA Office: AFSC, Kerim Aydin, Sponsor
Budget Amount: Cumulative $18,782, This year $0
This project is new, and it is on a no-cost extension until 09/30/2017.

Primary objectives

By collaborating with Alaska Fisheries Science Center NOAA personnel on algorithm and computer coding improvements, PI Gibson will provide support for the continued improvement of the Nutrient-Phytoplankton- Zooplankton (NPZ) component of Bering-10K marine ecosystem model. Discussion and updates will occur via weekly phone conferences and supplemental e-mail correspondence as need. The project deliverable will be a finalized version (version 2) of the NPZ code, which will include a merger of the various code branches that presently exist at IARC/UAF and AFSC/NOAA.

Research accomplishments/highlights/findings

Through this project, PI Gibson collaborated with NOAA personnel Kelly Kearney to develop and merge code updates from multiple versions of a lower trophic level marine ecosystem model for the Bering Sea (BEST NPZ). The collaboration was conducted by establishing a GIT, an open source distributed version control system. Notable updates that Gibson brought to the new version of the model include consumption of detritus by euphausiids, daily vertical migration of euphausiids in response to light levels, improved representation of benthic feeding and more realistic representation of feeding and respiratory behavior of zooplankton when in diapause. The overall project goal is near completion and version 2 of the NPZ code is anticipated to be finalized with the next few months under the awarded NCE.

NOAA relevance/societal benefits

The BEST NPZ model has previously been coupled to the NOAA developed Forage and Euphausiid Abundance in Space and Time (FEAST) model. FEAST is an upper trophic level fish model that was subsequently coupled to a management strategy evaluation model. The suite of coupled models is being used to perform hypothesis testing including evaluations of alternative management strategies for the Bering Sea pollock fishery. The work performed by Gibson under this CIFAR project provided integration of essential NPZ model updates into the suite of coupled models. Periodically assessing, updating, and

revising the algorithms used in the models is integral to ensuring that predictions of ecosystem and fisheries dynamics are as realistic and informative as possible.

Partner organizations and collaborators

Gibson performed this model update effort in conjunction with NOAA personnel Kelly Kearney.

Impact

The work performed by Gibson provided updated model code and improved functionality to a lower trophic level ecosystem model for the Bering Sea. This model in used internally by NOAA personnel to provide prey fields (secondary production estimates) to a higher trophic level fish model (FEAST). Together these models have enable and improved understanding of pollock fisheries dynamics in the Bering Sea.

Education

No outreach activities were planned or performed within Gibson's scope of work for this project.

Outreach

No outreach activities were planned or performed within Gibson's scope of work for this project.

Publications

The scope of work for Gibson's contribution to this model development effort did not include publications.

Conference presentations

Gibson did not perform any presentations related to this project.

Other products and outcomes

The work Gibson performed under this project has contributed to a newly updated lower trophic ecosystem model for the Bering Sea ecosystem. This model was originally developed by primarily by Gibson and is now used in house at NOAA's AFSC coupled to a higher trophic level fish model. Model updates are in their final stages under an awarded NCE and publications with the updated version of the model are expected to be forthcoming.

Support for US participation in the CBMP Expert Network

Russell R. Hopcroft, PI ***CIFAR theme: Ecosystem Studies and Forecasting***
University of Alaska Fairbanks

Other investigators/professionals associated with this project:
Katrin Iken, University of Alaska Fairbanks
Eric Collins, University of Alaska Fairbanks

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendment: 32, 59 NOAA Office: OAR, Jeremy Mathis, Sponsor
Budget Amount: Cumulative $57,471, This year $0
This project is set to end 06/30/2018.

Primary objectives

The Arctic Council's Conservation of Arctic Flora and Fauna (CAFF, www.caff.is) working group has developed the multi-national Circumpolar Biodiversity Monitoring Program (CBMP, www.cbmp.is). The CBMP seeks to coordinate pan-Arctic biodiversity monitoring through an international network of scientists working in conjunction with national agency representatives. The overall purpose of the CBMP is to determine the status of, and any changes within, six major components of Arctic biodiversity. These Expert Networks, each with equal representation by all primary participant countries, are tasked with coordination, data integration and data synthesis. Hopcroft and Iken have participated in the development of the implementation plan (Gill et al. 2011), with Hopcroft currently serving as the co-lead of the Pelagic Marine Expert Network, and both Iken and Collins serve as the US members of the Benthic and Sea Ice Biota Marine Expert Network, respectively.

Research accomplishments/highlights/findings

During 2016/17, the primary task has been completion of the State of the Arctic Marine Biodiversity Report (SAMBR), as a follow up to the Arctic Biodiversity Assessment (ABA) Report. The report consists of contributions by each of CBMP's Marine Expert Networks. A writing workshops was held in Akureyi, Iceland during October 2016. The report has undergone a number of internal reviews and is now in final stages of layout.

NOAA relevance/societal benefits

This project documents the state and examines the potential impacts of climate change in circumpolar Arctic domain. It provides interaction between the member countries of the Arctic Council.

Publications, conference papers, and presentations

CAFF. 2017. State of the Arctic Marine Biodiversity Report. Conservation of Arctic Flora and Fauna, Akureyri Iceland.

Partner organizations and collaborators

Circumpolar Biodiversity Monitoring Program (CBMP)

Conservation of Arctic Flora and Fauna (CAFF)

Partner organizations and collaborators

Ted Stevens Marine Research Institute, Alaska Fisheries Science Center, Juneau, Alaska (Peter-John Hulson).

Feeding habits of juvenile salmon, forage fish and scyphozoan jellyfish

Alexei Pinchuk, PI
University of Alaska Fairbanks

CIFAR theme: Ecosystem Studies and Forecasting

NOAA Goals: Healthy Oceans; Climate Adaptation and Mitigation

Amendment: 60 NOAA Office: NMFS, Kristen Cieciel, Sponsor
Budget Amount: Cumulative $27,247, This year $27,247 (Amendment 60)
This project is new, and it is set to end 06/30/2017.

Primary objectives

This work addresses the gap in our understanding of feeding ecology of juvenile salmon and forage fish as well as scyphozoan jellyfish, key pelagic predators in the Northern Bering Sea and Gulf of Alaska, where they are an integral component of local food webs. Fish stomachs from fish and individually preserved jellyfish are being analyzed for prey content. Samples of individually preserved jellyfish are examined for regurgitated prey and gastric pouches are inspected for prey leftovers.

- **For fish, stomach contents identified to the lowest feasible taxonomic group. Individual prey groups are weighed and divided by the total weight of prey contained in the stomachs to calculate proportional contributions of each prey group to the diet.**
- **For jellyfish, prey items are identified to the lowest taxonomic level possible, counted and weighed to obtain estimates of individual and total prey weights.**
- **We will generate a relational MS ACCESS data base for stomach contents which can be linked to physical and zooplankton data collected simultaneously.**
- **We will analyze diversity in fish and jellyfish diets in relation to physical conditions and prey fields observed in the study area.**
- **We will provide assistance as requested to Dr. Farley as he prepares his final report for this program. This assistance will include data interpretation (as necessary) and review of the final report.**
- **We will share analytical software, if requested, with Dr. Farley to help expedite analyses that he elects to pursue with the data.**

Research accomplishments/highlights/findings

Up to date over 100 individual scyphozoan jellyfish (*Chrysaora melanaster*) collected during late summer from the southeaster Bering Sea have been analyzed for prey content. The jellyfish ranged between 15-100 cm (bell diameter). The jellyfish were feeding mainly on neritic and nearshore copepods (*Oithona similis, Centropages abdominalis, Pseudocalanus spp, Acartia longiremis, Acartia hudsonica*) with small numbers of cladocerans and newly hatched pteropods *Limacina helicina*. The taxonomic composition of the prey is indicative of the Alaska Coastal water mass. The copepods were represented by adult and copepodite stages which is typical for the late summer condition. Generally low numbers of prey indicate less than the optimal feeding conditions for the jellyfish in the Alaska Coastal water during that particular season and location.

NOAA relevance/societal benefits

Commercially harvested salmon, as well as forage fish and jellyfish play a central role in the food web of the southeastern Bering Sea and Gulf of Alaska, where they potentially compete for available zooplankton prey. A better understanding of their feeding ecology and their interactions with different ecosystem components would enhance our ability to success fully model these populations via changing prey and prey quality as they are mediated by changing climatic conditions.

Partner organizations and collaborators

none

Education

Not applicable.

Outreach

Not applicable.

Publications

Not applicable.

Conference presentations

Not applicable.

Other products and outcomes

Not applicable.

High latitude proving ground–improving forecasts and warnings by leveraging GOES-R investment to deliver and test NPP/JPSS data in support of operational forecasters

Tom Heinrichs, PI ***CIFAR themes: Climate Change and Variability, Coastal Hazards***
University of Alaska Fairbanks

Other investigators/professionals associated with this project:
Jessica Cherry, Eric Stevens, Carl Dierking Jiang Zhu, Jay Cable, Scott Macfarlane, Will Fisher, Dayne Broderson, University of Alaska Fairbanks

NOAA Goal: Climate Adaptation and Mitigation

Amendments: 8, 19, 42, 50, 62 NOAA Office: NESDIS, Christopher W. Brown, Sponsor
Continues research from NA08OAR4320751
Budget Amounts: Cumulative $1,016,547, This year $570,622 (Amendments 50 and 62)
This project is set to end 12/31/2017.

Primary objectives

The objective of this activity is to build upon the already established collaborative team of National Weather Service (NWS) Alaska Region, University of Alaska Fairbanks-Geographic Information Network of Alaska (UAF-GINA), National Environmental Satellite, Data, and Information Service (NESDIS), and Cooperative Institute for Meteorological Satellite Studies (CIMSS), Cooperative Institute for Research in the Atmosphere (CIRA), and Short-term Prediction Research and Transition Center (SPoRT) to improve the near real-time distribution of the Suomi National Polar-orbiting Partnership (SNPP)/Joint Polar Satellite System (JPSS) data to algorithm developers, science users, and the operational NWS forecast offices.

In cooperation with University of Wisconsin, Colorado State, and National Oceanic and Atmospheric Administration (NOAA) Center for Satellite Applications and Research (STAR) algorithm developers and direct broadcast application developers, UAF-GINA will provide an operational environment to run the Community Satellite Processing Project (CSPP) SNPP sensor processor. Both the stable and pre-release development processors for the SNPP sensors will be generating products in near real-time for distribution to the Alaska NWS and algorithm developers at other university and NOAA research sites. These products delivered to the Alaska NWS will initially include natural color and infrared imagery in near-real-time. GINA staff will work closely with NOAA and Cooperative Institutes to train, deploy, and evaluate products in Alaska Region forecast offices and river, aviation, and sea ice units.

Research accomplishments/highlights/findings

- **Supported forecasters at the Alaska Aviation Weather Unit in May in the use of new satellite products to forecast aviation weather.**

The satellite liaison to the Aviation Weather Center (AWC), Amanda Terborg, traveled to Anchorage twice during the reporting period to work with forecasters at the Alaska Aviation Weather Unit (AAWU) and share some of the techniques used by forecasters at the national Aviation Weather Center in Kansas City.

GINA science liaison Eric Stevens accompanied Amanda in Anchorage and facilitated a meeting with staff at the NWS' Center Weather Service Unit (CWSU) at the FAA's air traffic control center at Elmendorf Air Force Base in Anchorage. Eric gave presentations to CWSU forecasters about NUCAPS and multispectral products, and a follow-up session on these topics was conducted remotely two weeks later. Figure 1 shows an instance during which the CWSU issued a warning based on information from interrogating near-real-time NUCAPS (NOAA-Unique Combined Atmospheric Profile System) sounding data from GINA's direct readout station. NASA SPoRT has also supported the NUCAPS work for the "cold air aloft" phenomenon.

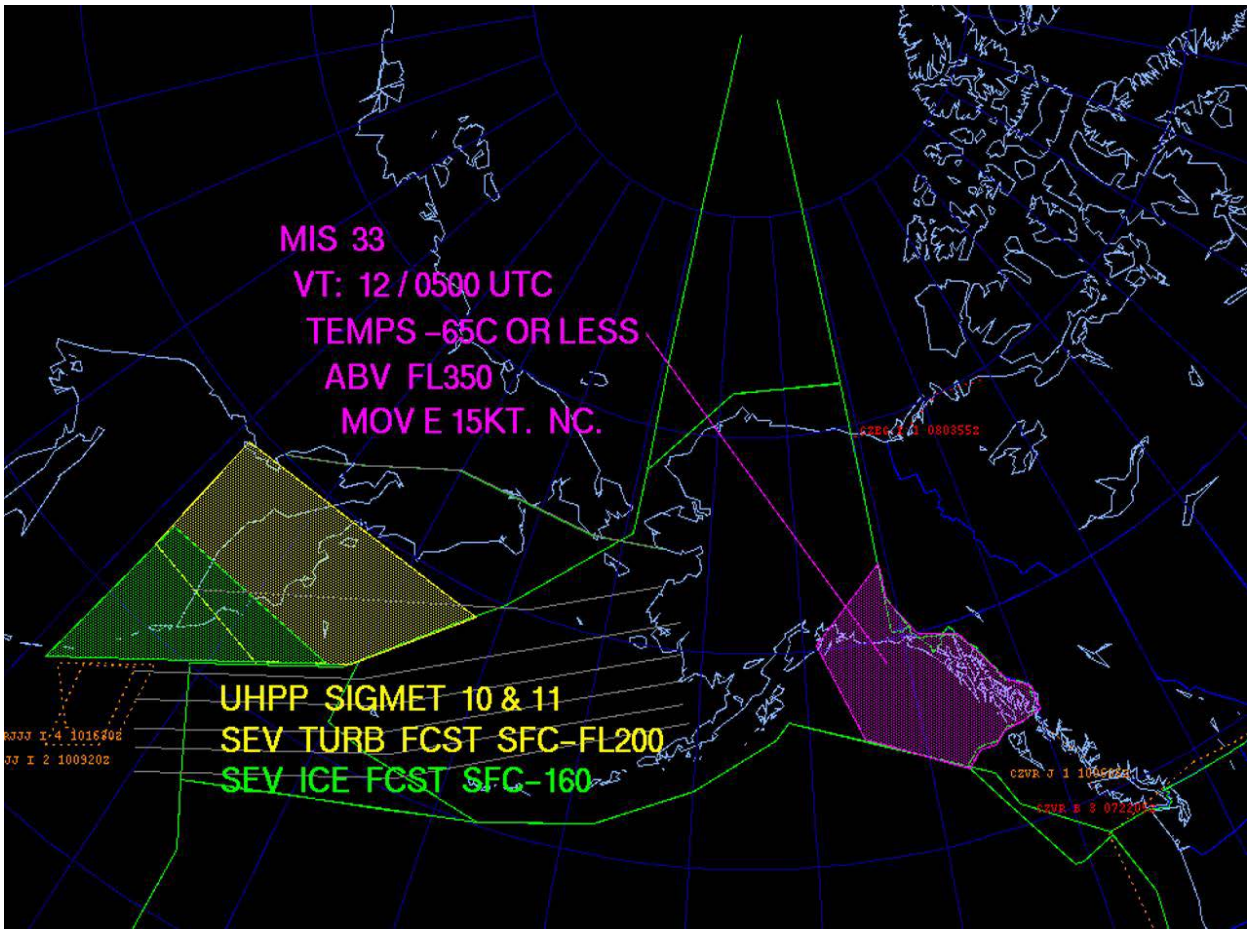


Figure 1. Hazard graphic produced by forecasters at the Anchorage CWSU on January 11, 2017 for use by FAA air traffic controllers. The magenta area over Southeast Alaska indicates the "cold air aloft" phenomenon. CWSU forecasters have indicated that NUCAPS data is helpful for them in forecasting this hazard

- **An assessment of the use of NUCAPS by forecasters in Alaska began on June 1st.**

GINA began facilitating an assessment of NUCAPS (NOAA-Unique Combined Atmospheric Profile System) from June to August 2016. NWS forecasters in the CONUS have had some success in using NUCAPS profiles to diagnose the pre-severe convective environment. The goal of the assessment in Alaska is to familiarize forecasters with NUCAPS as well as to gauge the utility of NUCAPS profiles during the summer wildfire season. In support of this effort, a blog site was started: http://nucapsalaska.blogspot.com/ An AWIPS screen

capture showing the overlap between a VIIRS true color RGB and the corresponding NUCAPS points is shown in figure 2. Figure 3 shows a closer view of the data.

The utility of NUCAPS soundings in the fire weather environment was evaluated at WFO Fairbanks and Alaska Fire Service during the summer. The primary success was in training forecasters regarding the basics of NUCAPS, including how access the profiles in Advanced Weather Interactive Processing System (AWIPS) and display them using the Pop-up Skew-T and NSHARPS.

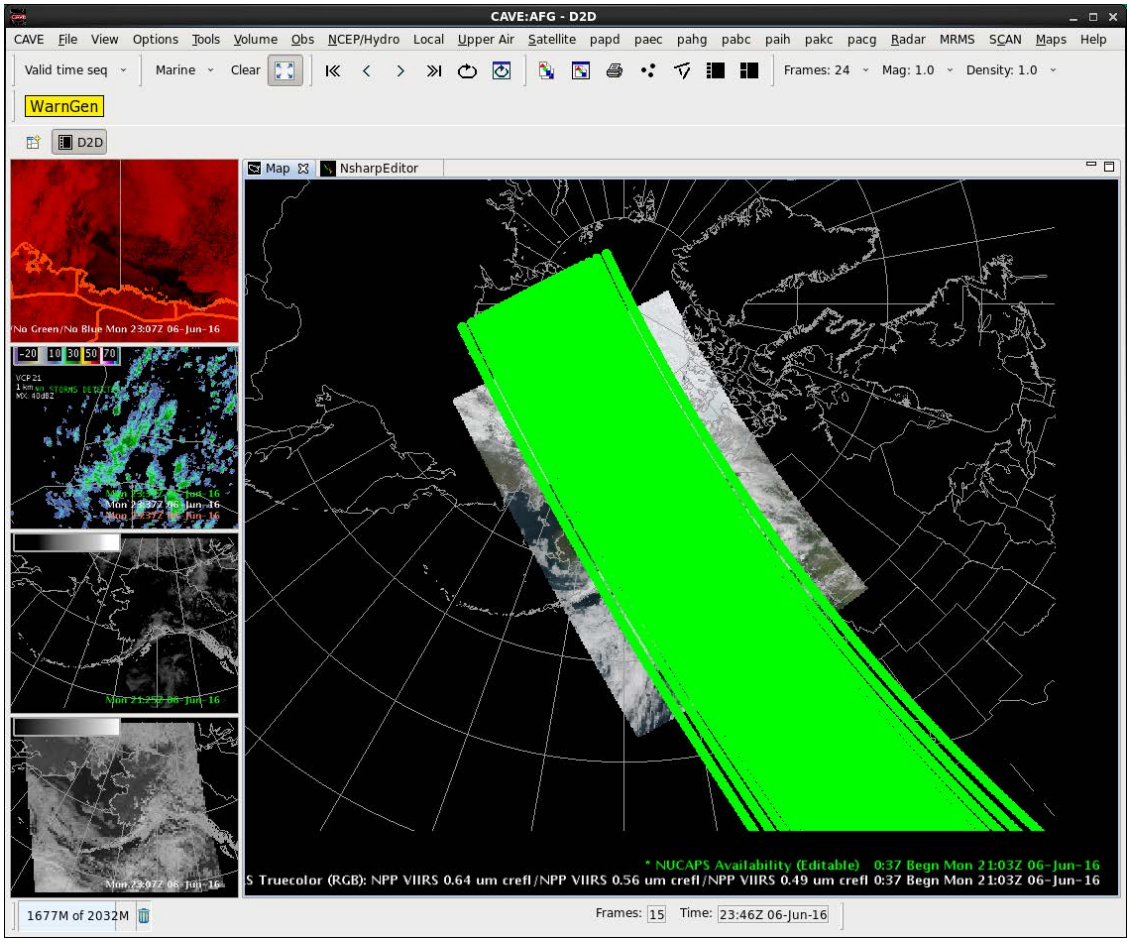


Figure 2: AWIPS screen capture from WFO Fairbanks showing NUCAPS points (green dots, densely arrayed) overlaid on a VIIRS true color image from the same pass of the SNPP satellite.

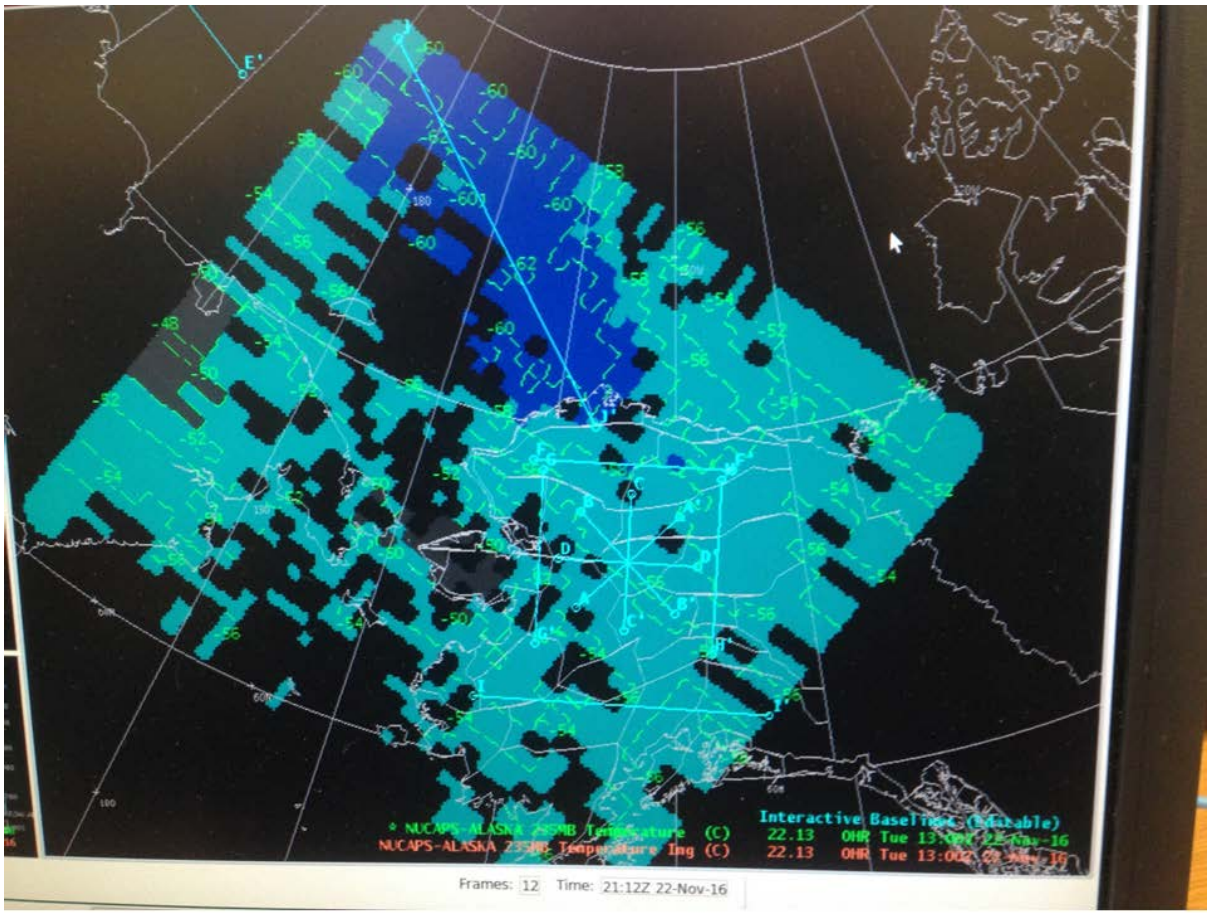


Figure 3 Sample planar view of live gridded NUCAPS on the operational AWIPS at the NWS forecast office in Fairbanks, Alaska.

- **Enhancements viewing of satellite products in NWS AWIPS software.**

In 2015, GINA, SPoRT, and the NWS worked together to bring the capability to generate RGB products on AWIPS2 workstations. This is known as "client-side" RGB production, or RGB production "on the fly." The advantages of this approach include greater flexibility in customized product generation at the forecast offices, more meaningful mouse roll-over information in the RGBs on AWIPS, and greater bit-depth of the resulting RGBs. More RGB products were added during this reporting period in 2016. The script that generates mosaics of polar orbiter imagery within AWIPS was upgraded to include a "time delta" that allows the forecaster to view color-coded ages of the various individual passes that comprise the mosaic. Figures 4a and 4b show examples of both the resulting mosaic and the assignment of "time deltas" to the various passes that compose the mosaic.

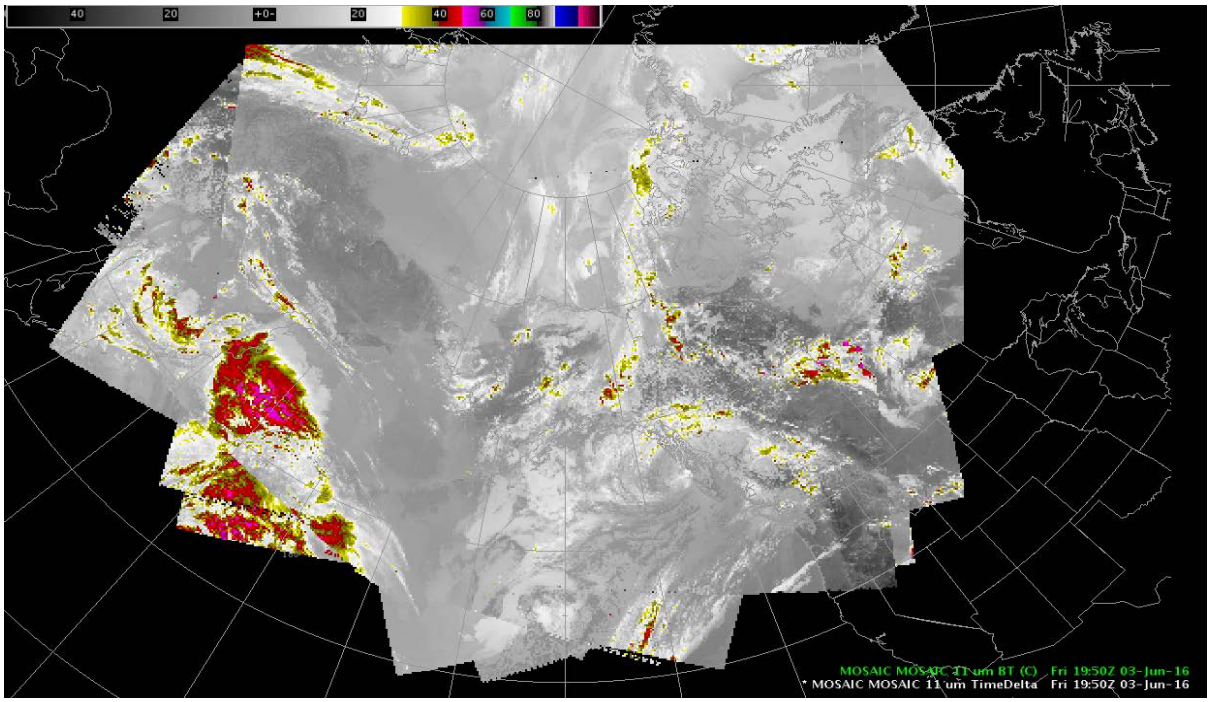


Figure 4a: Sample mosaic of longwave IR imagery built within AWIPS from a number of polar orbiting satellites using GINA's new composting script.

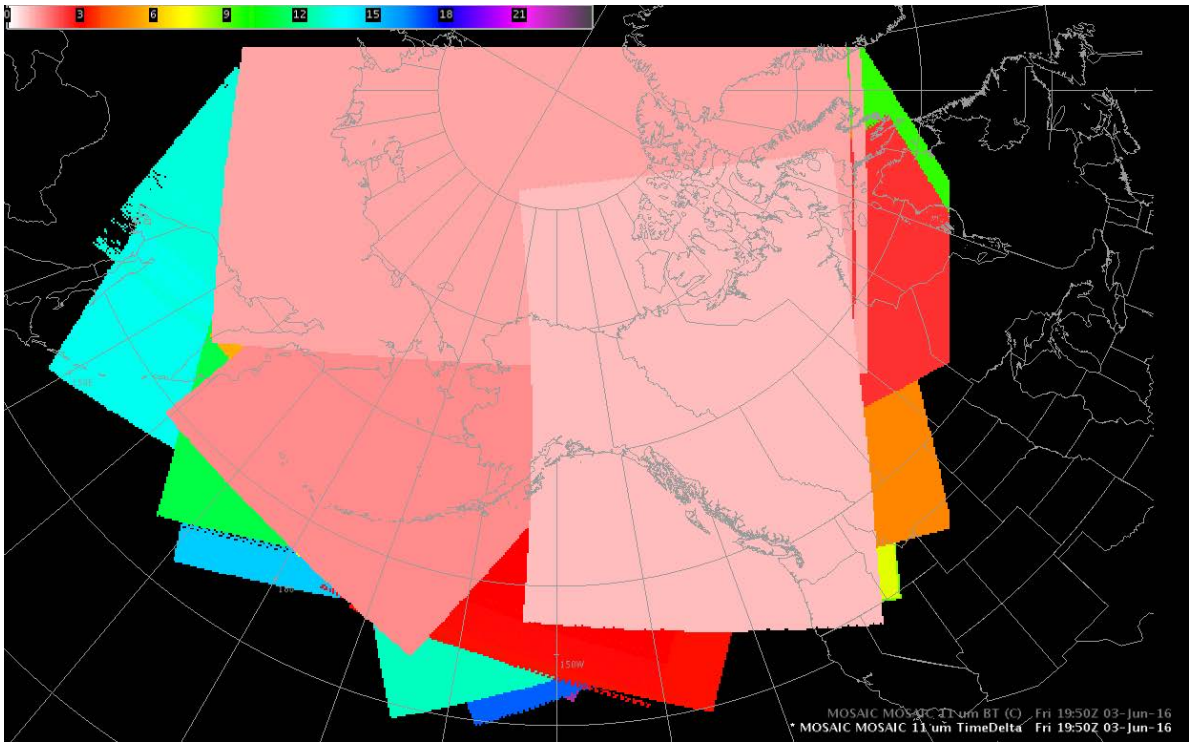


Figure 4b: Depiction of the "time delta" for each of the passes used to build the mosaic depicted in figure 4a. Per the scale bar at the top of the image, each swath is assigned a color indicating its age in hours.

- **Work continues in using NUCAPS profiles in the data assimilation process for local NWP modeling.**

GINA receives CrIS and ATMS data via direct broadcast, and the resulting NUCAPS profiles are being incorporated into the data assimilation process for WRF NWP run over Alaska. More information about this project is available at http://gina.alaska.edu/projects/gina-wrf-short-term-forecast Output from the WRF model can be found at http://gina.alaska.edu/projects/gina-wrf-short-term-forecast

A month-long study of the impact of GINA's direct broadcast data on data assimilation in local numerical modeling was concluded. The effects of 3Dvar and hybrid 3Dvar-ENKF data schemes on the WRF short-term forecasts were compared, and NUCAPS profiles were used in the data assimilation experiment. Jiang Zhu presented results in a poster session at the American Meteorological Society (AMS) annual meeting in January 2017. Dr. Zhu's poster was titled "Hybrid EnKF-3DVAR Data Assimilation Improves Alaska Short-term Forecasts," and shows the latest progress in enhancing a WRF run over an Alaskan nest by including CrIS and ATMS returns in the data assimilation process of the model. The main purpose of the study was to learn whether the Hybrid EnFK-3Dvar approach performs better than the 3Dvar data scheme. Based on assimilation of only conventional and CrIS/ATMS profile data, the hybrid 3dvar-ENKF runs showed no significant improvement over the 3dvar runs.

- **JPSS-1 readiness preparation is well underway.**

Considerable effort has been invested in getting GINA's direct readout satellite reception systems prepared for the NOAA's next generation polar orbiting satellite, JPSS-1, launch planned for September 2017. We have deployed a new testing environment that enables testing of CSPP upgrades on a non-operational platform at GINA. Prior to this upgrade, operations and development needed to be conducted on the same platform, thereby introducing the risk that development work could inadvertently interrupt GINA's operational support to near-real-time users of GINA's products, such as the NWS. A new, significantly upgraded production environment was also deployed. CSPP was upgraded. Distribution systems were enhanced. Planning and coordination among GINA, NWS Alaska Region, University of Wisconsin CSPP team, and JPSS program office staff has been ongoing and all indications are that GINA will be able to provide JPSS-1 data to the Alaska NWS on "day one" as systems go operational on the satellite.

- **Several prototypes derived from GINA's direct broadcast microwave data were developed in December 2016 and will be tested in operations starting in April 2017.**

Data from the various microwave instruments on satellites tracked by GINA can now be processed with the CSPP and Polar2Grid software to generate depictions of sea ice, snow water equivalent (SWE), and total precipitable water (TPW). A handful of prototype products were generated as a proof of concept, with the vision that these products will eventually be generated routinely by GINA and delivered to the NWS in near real time for use in forecast operations. Despite their coarser spatial resolution, these products offer several advantages for forecasters, including the ability to function under both clear and cloudy conditions, and to function day or night. See Figures 5, 6, and 7 for examples of these new products. These products will be tested in operations by the NWS Alaska Sea Ice Program starting in April 2017.

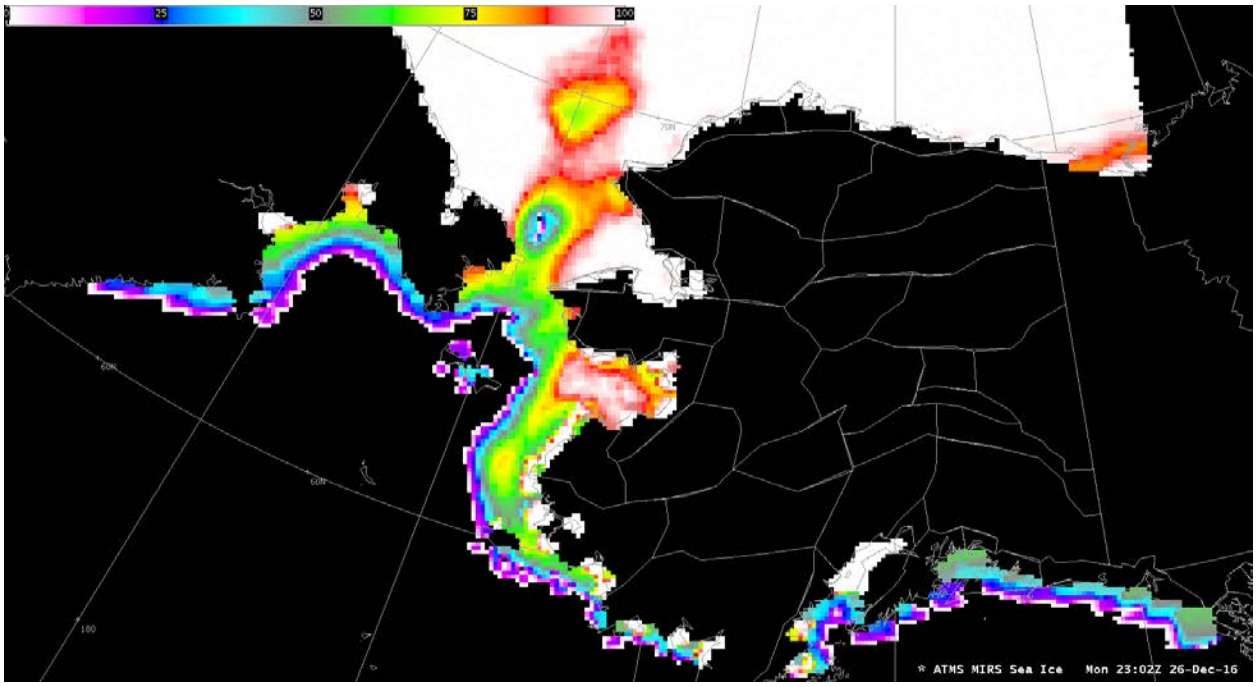


Figure 5. Prototype sea ice graphic derived from GINA's direct broadcast ATMS data. This product will be particularly useful for the NWS Alaska Sea Ice Program, especially during the winter when products requiring incoming shortwave radiation from the sun are not available.

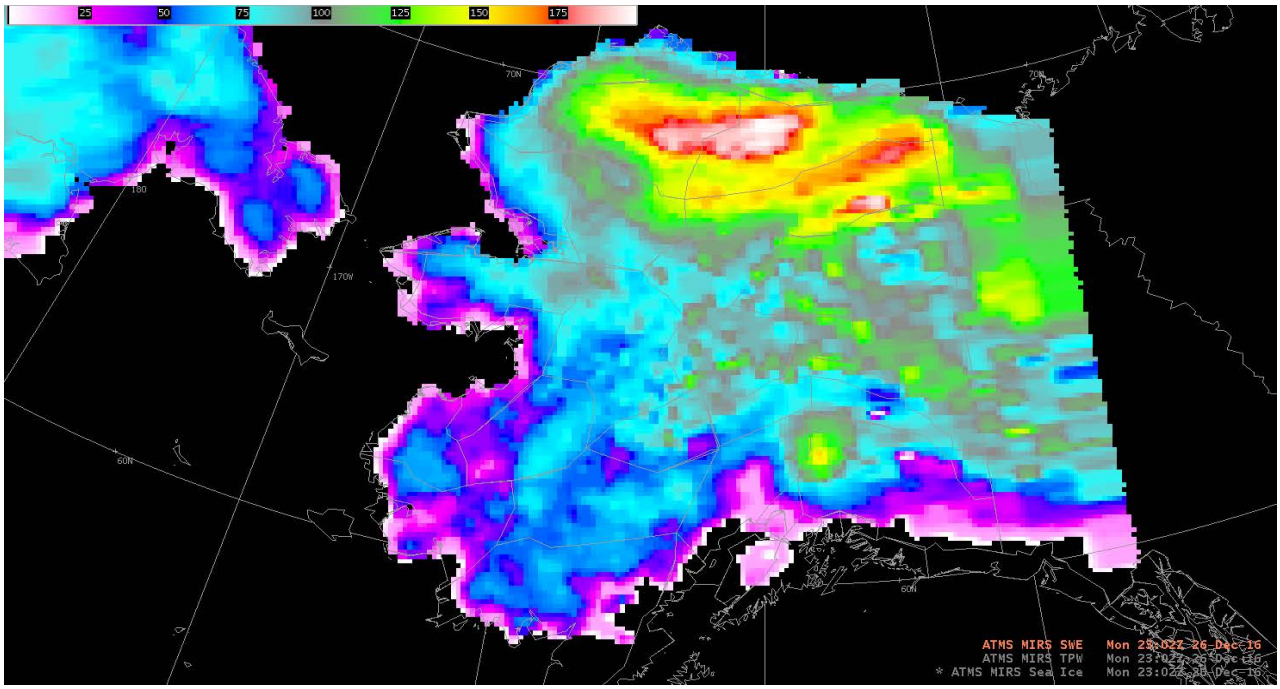


Figure 6. Prototype snow water equivalent derived from GINA's direct broadcast ATMS data. This product will be applicable during Alaska's annual spring breakup as the snow melts and the resulting runoff fills Alaska's rivers and influences the likelihood and severity of ice jam flooding.

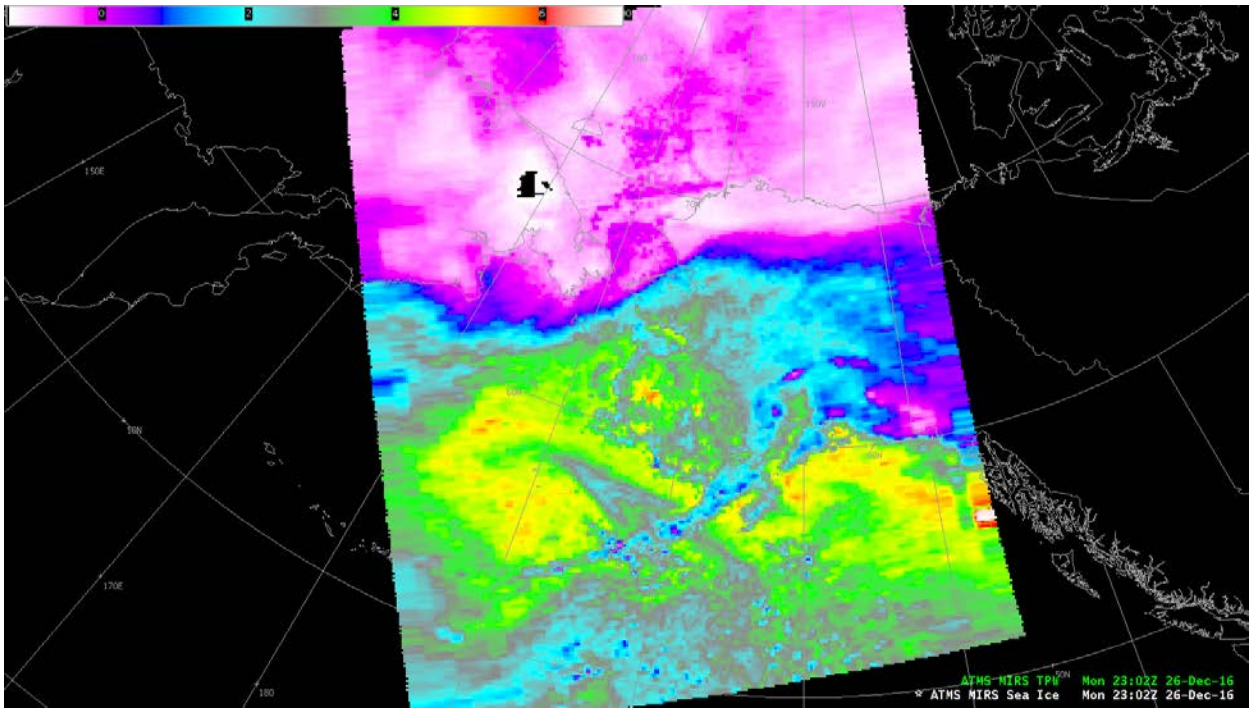


Figure 7. Prototype total precipitable water derived from GINA's direct broadcast ATMS data. Precipitable water is always useful, particularly during weather scenarios involving "atmospheric rivers" which can yield intense concentrated rainfall in coastal locations.

NOAA relevance/societal benefits

The National Weather Service, Alaska Region, is the largest operational forecasting user of polar orbiting satellite data in NOAA because of its unique high latitude location and forecasting and warning domains. In addition to polar orbiting data, geostationary satellite data is used effectively in southeast Alaska and the Aleutians and as a synoptic tool for the rest of the state. Effective use of polar orbiting data is essential for accurate forecasting and warning at high latitudes.

Partner organizations and collaborators

NOAA National Weather Service: Collaborative research, Facilities

NOAA NESDIS, Fairbanks Command and Data Acquisition Station: In-kind support, Facilities, Collaborative Research

NOAA NESDIS Center for Satellite Applications and Research (STAR), In-kind support, Collaborative Research

UW-Madison CIMSS: In-kind support, Collaborative research, Personnel exchanges

UW-Madison Space Science and Engineering Center (SSEC): In-kind support, Collaborative research, Personnel exchanges

Colorado State University CIRA: In-kind support, Collaborative research, Personnel exchanges

NASA Direct Readout Laboratory: In-kind support, Collaborative research, Personnel exchanges

Education and Outreach

On June 16, 2016, science liaison Carl Dierking represented the satellite proving ground at an open house hosted by NWS forecast office Juneau. Carl spoke with the public about the new generation of weather satellites and what they mean to Alaska.

Science liaison Eric Stevens worked with forecasters at the US Air Force's 17th Operational Weather Squadron (OWS) in Hickam Air Force Base, Honolulu, Hawaii. Forecasters at the 17th OWS have responsibility for the USAF's aviation forecasts and pilot briefings in Alaska, and Eric gave a series of presentations on the use of satellite imagery in the production of aviation forecasts in Alaska. Staff from the 17th OWS and Eric also discussed opportunities for collaboration in the future between the USAF and the satellite proving ground.

Dr. Evan Ellicott visited Fairbanks in July. Dr. Ellicott of the University of Maryland traveled to Fairbanks to work with staff at Alaska Fire Service and GINA to streamline the use of GINA's direct broadcast data in generating imagery and products to support fire weather analysis and forecasting.

The inaugural instalment of the Virtual Alaska Weather Symposium was launched on March 15 with a webinar addressing satellite imagery and products useful during spring breakup in Alaska. GINA has teamed up with the National Weather Service in Alaska and the Alaska Center for Climate Assessment and Policy to host a series of monthly webinars, the Virtual Alaska Weather Symposium (VAWS). This initial webinar was given by Jessie Cherry of the Alaska Pacific River Forecast Center and Eric Stevens of GINA on the topic of using satellite imagery and products in the spring breakup context. One of the strengths of the VAWS series of webinars is that they are recorded and archive for later reference. This webinar is available at https://accap.uaf.edu/VAWS_Breakup .

Publications

None to report at this time.

Conference presentations

Dierking, C. 2016. Government and Academic Remote Sensing Partnerships for Near-Real-Time Support for US National Weather Service. EUMETSAT Satellite Conference in Darmstadt, Germany, September 2016.

Dierking, C. 2016. Remote Sensing Support for the National Weather Service's Alaska Sea Ice Program. EUMETSAT Satellite Conference in Darmstadt, Germany, September 2016.

Stevens, E. 2016. The Whole is Greater than the Parts: Client-Side Multi-Spectral Imagery in Alaska. Proving Ground User Readiness in Norman, Oklahoma, May 2016.

Zhu, J. 2017. Hybrid EnKF-3DVAR Data Assimilation Improves Alaska Short-term Forecasts," Poster presentation at American Meteorological Society Annual Meeting in Seattle, Washington, January 2017.

Other products and outcomes

Visiting scientists hosted: Sanmei Li of George Mason University visited in April 2016 to observe Yukon River breakup and validate her satellite derived flooding products. Amanda Terborg of the Aviation Weather Center visited in May 2016 and January 2017 to work with AAWU and CWSU aviation forecasters. Evan Ellicott of the University of Maryland visited in August 2016 to work with GINA and the Alaska Fire

Service on satellite wildfire products. Kathy Strabala and Jordan Gerth visited in August 2016 to work with GINA on satellite data processing and to interview NWS WFO staff. Lori Schultz and Kevin McGrath of NASA SPoRT visited in September 2017 to work on AWIPS client side RGB and NUCAPS with GINA and the NWS WFOs. Michael Folmer of the Ocean Prediction Center visited GINA and the Alaska WFOs in March 2017 to work on multispectral oceanic products.

High Latitude proving ground for GOES-R: Advanced data products and applications for Alaska

Thomas Heinrichs, PI ***CIFAR themes: Climate Change and Variability, Coastal Hazards***
University of Alaska Fairbanks

Other investigators/professionals associated with this project (w/affiliation):
Jessica, Cherry, Eric Stevens, Carl Dierking, Jiang Zhu, University of Alaska Fairbanks

NOAA Goal: Climate Adaptation and Mitigation

Amendments: 18, 33, 48 NOAA Office: NESDIS, Steven Goodman, Sponsor
Continues research from NA08OAR4320751
Budget Amounts: Cumulative $610,264, This year $207,798 (Amendment 48)
This project is set to end 06/30/2017.

Primary objectives

Based on needs of the National Weather Service, the Geographic Information Network of Alaska (GINA) at the University of Alaska Fairbanks performs the following research efforts centered on the themes of 1. Cryospheric products; 2. Assimilation of products into models; and 3. Hazardous weather. The primary objectives of the proposed work are to enhance existing satellite data services and research in Alaska and develop next generation scientific products from satellite data. Collaboration include the NWS Weather Forecast Offices (WFOs), the Alaska Pacific River Forecast Center (APRFC), the Alaska Aviation Weather Unit (AAWU), and the Alaska Sea Ice Program (SIP), and the NOAA research partners: Cooperative Institute for Meteorological Satellite Studies--CIMSS, Cooperative Institute for Research in the Atmosphere—CIRA, NOAA Center for Satellite Applications and Research--STAR, Short-term Prediction Research and Transition and Center-- SPoRT, and the NOAA National Operational Hydrologic Remote Sensing Center (NOHRSC).

Research accomplishments/highlights/findings

- **Supported forecasters at the Alaska Aviation Weather Unit in May in the use of new satellite products to forecast aviation weather.**

The satellite liaison to the Aviation Weather Center (AWC), Amanda Terborg, traveled to Anchorage twice during the reporting period to work with forecasters at the Alaska Aviation Weather Unit (AAWU) and share some of the techniques used by forecasters at the national Aviation Weather Center in Kansas City. GINA science liaison Eric Stevens accompanied Amanda in Anchorage and facilitated a meeting with staff at the NWS' Center Weather Service Unit (CWSU) at the FAA's air traffic control center at Elmendorf Air Force Base in Anchorage. Amanda and Eric also recorded video segments about the use of new satellite products for the statewide public television program "Alaska Weather." Figure 1 is an example of a GOES-R product produced with MODIS data indicating aircraft icing threat (GOES-R Future Product: Aircraft Icing Threat).

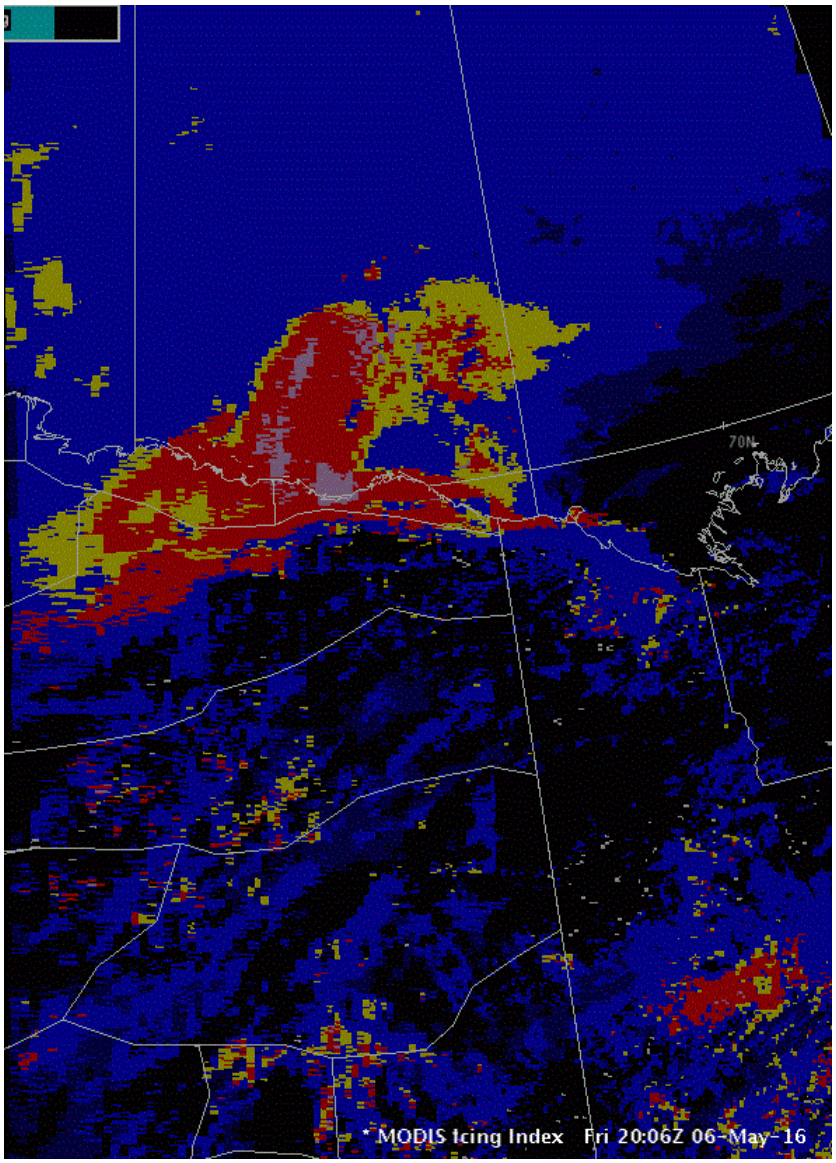


Figure 1: Screen capture from the NWS AWIPS at the Alaska Aviation Weather Unit in Anchorage. This is the new "Icing Threat Index" product introduced to the AAWU by Amanda Terborg. In this case, the product indicates a high likelihood of icing over the eastern half of Alaska's North Slope. Pilot reports from this area at this time verified the presence of icing.

- **"On the fly" RGBs in AWIPS.**

GINA satellite data liaison Carl Dierking has continued to provide strong leadership, developed AWIPS configurations, and trained Alaska NWS forecasters in the use of RGB products generated directly in AWIPS. In 2015, GINA, SPoRT, and the NWS worked together to bring the capability to generate RGB products on AWIPS2 workstations. This is known as "client-side" RGB production, or RGB production "on the fly." The advantages of this approach include greater flexibility in customized product generation at the forecast offices, more meaningful mouse roll-over information in the RGBs on AWIPS, and greater bit-depth of the resulting RGBs. More RGB products were added during this reporting period in 2016. An example is the Ash RGB: VIIRS single-band imagery can be combined into a multi-spectral RGBs to highlight

the plumes of volcanic ash (figure 2), and this technique can now be applied entirely within AWIPS via the "client-side" approach. Another example highlighting fog at night on Alaska's North Slope with the Nighttime Microphysics band combinations is shown in Figure 3.

This capability is especially important in the GOES-R/16 era with the many new spectral bands available from the Advanced Baseline Imager (ABI) on the new generation of GOES satellites. There are too many possible band combinations to generate remotely and transmit to WFOs. Liaison Dierking has worked with partners and NWS IT and science staff to deploy relevant RBB configurations to WFO AWIPS workstations in Alaska. They are currently in use for VIIRS and MODIS data but are completely applicable to ABI data. With a GOES-West ABI available in late 2018, this work will enable forecasters to be immediately productive with GOES-17 ABI data.

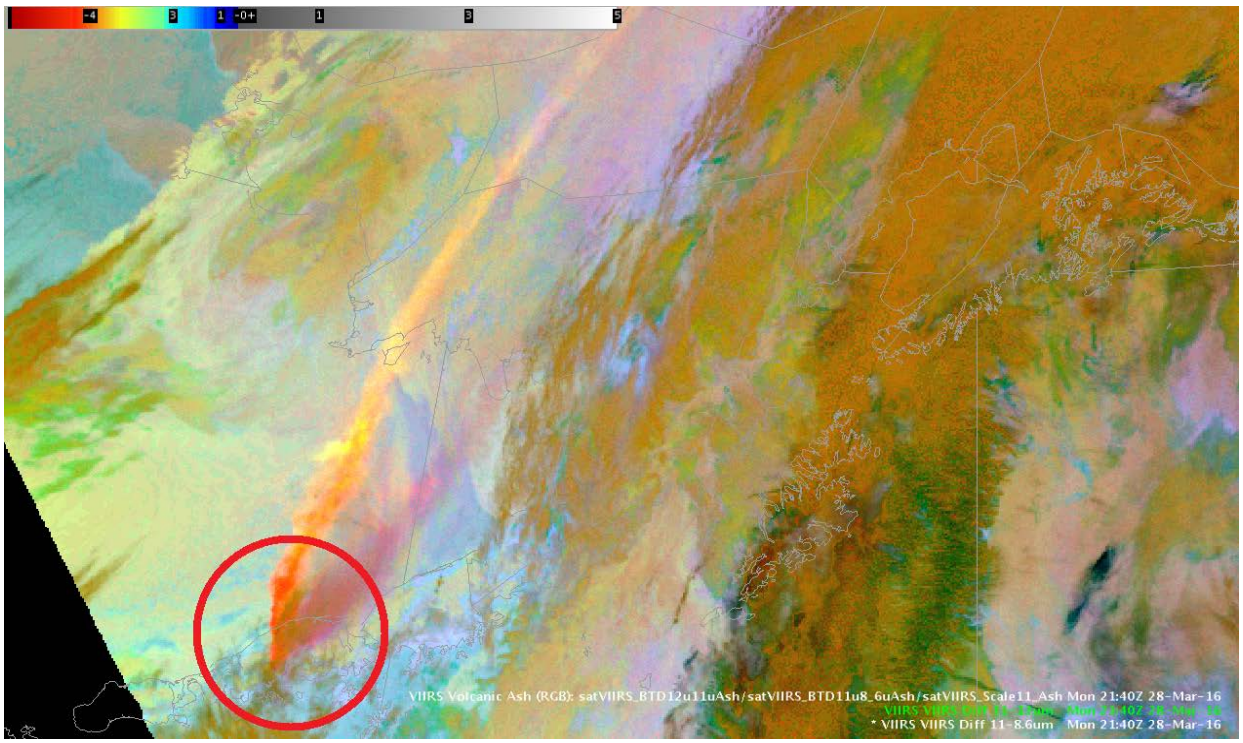


Figure 2: VIIRS-based multispectral RGB that highlights plumes of volcanic ash. This example uses archived data from the eruption of Pavlov Volcano in March of 2016 and was generated using the client-side approach within AWIPS. Pavlov is circled in red, and the ash plume is the orange-yellow plume being blown to the north-northeast by the ambient wind. The same technique will work with GOES-R series ABI data.

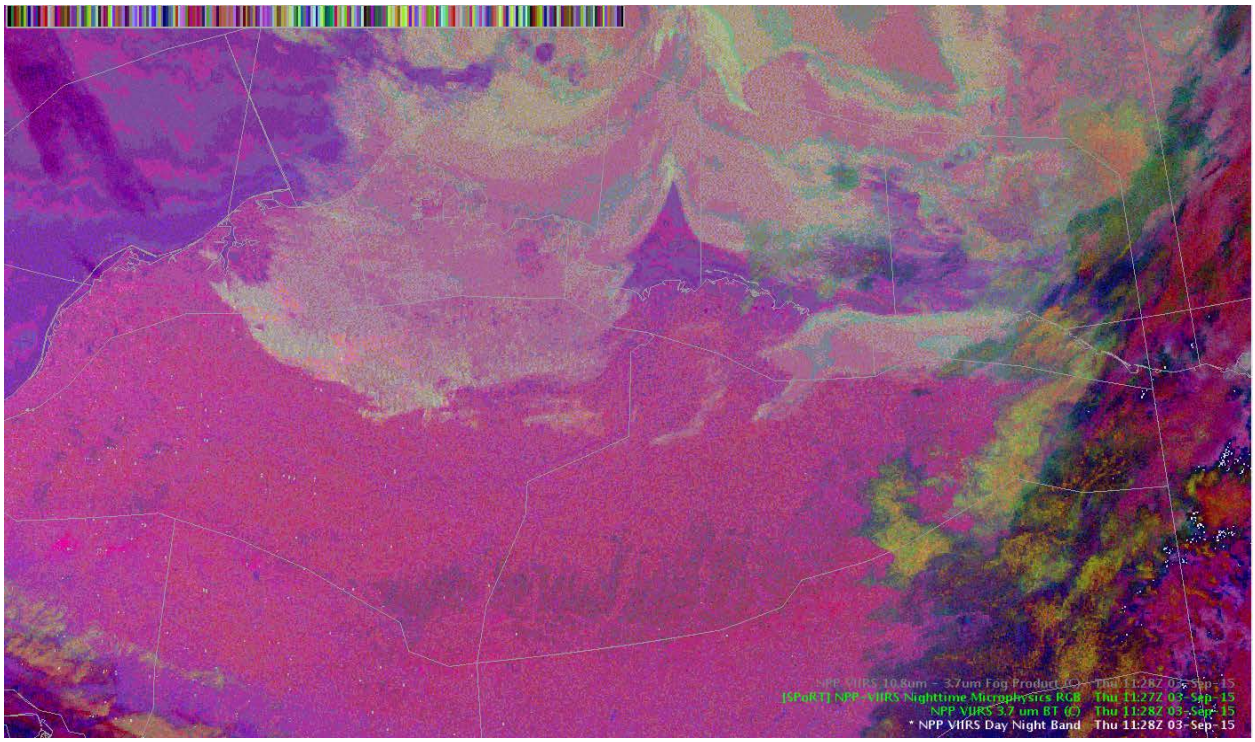


Figure 3: VIIRS-based multispectral RGB that highlights fog in light green using a Nighttime Microphysics spectral band combination. This example uses archived data from September 2015 to show a fog event on Alaska's North Slope at night. It was generated using the client-side approach within AWIPS. The same technique will work with GOES-R series ABI data.

- **Data from GINA direct readout station is being used to generate near-real-time GOES-R Volcanic Ash baseline products and Low Cloud and Fog pathfinder products.**

In preparation for GOES-R series ABI data being available in Alaska, GINA has been working with STAR and CIMSS scientists at the University of Wisconsin to produce ABI analog products for volcanic ash and low clouds and fog. GINA captures MODIS data which is sent to Madison for processing then sent back to GINA for distribution to the Alaska NWS via the Local Data Manager (LDM). These products are especially useful to forecasters at the Alaska Aviation Weather Unit.

- **Orthomosaics of river ice and flood conditions for the NWS Alaska Pacific River Forecast Center (APRFC).**

With complementary support from the COMET program and coordination with the APRFC and National Water Center, Jessica Cherry collected airborne imagery of river ice and flood conditions of the upper Yukon River during breakup during May 2016. Snow surveys with her sensor package were also compared to surveys using Gamma Ray detectors by NOAA's National Operational Hydrologic Remote Sensing Center. The river ice breakup imagery proved tremendously valuable to the APRFC forecasters as an ice jam formed just below the village of Eagle and water started backing up into the community. Dr. Sanmei Li of George Mason University was able to travel to Eagle and see the ice jam for herself. There is an effort now to extend her VIIRS-based river flood algorithm to the GOES sensor suite, so it was extremely useful

for her to observe this flooding in person from the ground and the air. Li was able to observe the distinction between snowmelt and flood waters near the Yukon, for example. Cherry subsequently joined NOAA's APRFC in January 2017 as a staff member and a remote sensing and data assimilation focal point.

- **Satellite data assimilation work for local NWP modeling and collaboration with NOAA ESRL on HRRR modeling**

GINA scientist Jiang Zhu continued his numerical weather prediction (NWP) modelling work both with a local WRF model and more recently in collaboration with the NOAA Earth System Research Laboratory (ESRL) on High Resolution Rapid Refresh (HRRR) modeling for Alaska. His focus is on data assimilation impacts on model performance. The GOES-R relevant products in use for the HRRR-Alaska are atmospheric motion vectors (AMV) that are highly impactful to model skill. Both GOES and polar orbiting derived AMVs contribute. GINA also receives CrIS and ATMS data from SNPP via direct broadcast, and the resulting profiles are being incorporated into the data assimilation process for WRF NWP run over Alaska.

A month-long study of the impact of GINA's direct broadcast data on data assimilation in local numerical modeling was concluded. The effects of 3Dvar and hybrid 3Dvar-ENKF data schemes on the WRF short-term forecasts were compared, and NUCAPS profiles were used in the data assimilation experiment. Jiang Zhu presented results in a poster session at the American Meteorological Society (AMS) annual meeting in January 2017. Dr. Zhu's poster was titled "Hybrid EnKF-3DVAR Data Assimilation Improves Alaska Short-term Forecasts," and shows the latest progress in enhancing a WRF run over an Alaskan nest by including CrIS and ATMS returns in the data assimilation process of the model. The main purpose of the study was to learn whether the Hybrid EnFK-3Dvar approach performs better than the 3Dvar data scheme. Based on assimilation of only conventional and CrIS/ATMS profile data, the hybrid 3dvar-ENKF runs showed no significant improvement over the 3dvar runs. This work focused on the impacts of sounder data on NWP; however, starting in early 2017, Dr. Zhu is actively and with full focus pursuing the assimilation of AMVs into HRRR for Alaska.

NOAA relevance/societal benefits

The focal areas of sea ice, river ice/flood, and aviation weather were directly targeted at weather and environmental hazards to people and property in Alaska. Improvements to forecasting these hazards have a significant benefit here in our state.

The National Weather Service Alaska Region is much more dependent on satellite data than CONUS NWS regions due to the sparse network of radars, surface observations, and balloon launches. The forecast area of responsibility for the Alaska Region is vast and includes large ocean areas, including the Bering Sea and Strait, North Pacific, and Arctic Ocean. The Alaska is the largest operational forecasting user of polar orbiting satellite data in NOAA because of its unique high latitude location and forecasting and warning domains. In addition to polar orbiting data, geostationary satellite data is used effectively and extensively in southeast Alaska and the Aleutians and as a synoptic tool for the rest of the state. With the much enhanced spatial, spectral, and temporal resolution of ABI data, it is certain that the GOES-West/17 ABI will be a critical forecasting support tool in Alaska.

Partner organizations and collaborators

NOAA National Weather Service: Collaborative research, Facilities

NOAA NESDIS, Fairbanks Command and Data Acquisition Station: In-kind support, Facilities, Collaborative Research

NOAA NESDIS Center for Satellite Applications and Research (STAR), In-kind support, Collaborative Research

NOAA National Operational Hydrologic Remote Sensing Center (NOHRSC), Collaborative Research

UW-Madison CIMSS: In-kind support, Collaborative research, Personnel exchanges

UW-Madison Space Science and Engineering Center (SSEC): In-kind support, Collaborative research, Personnel exchanges

Colorado State University CIRA: In-kind support, Collaborative research, Personnel exchanges

Education and Outreach

Cherry continued to supervise a PhD student, Molly Tedesche, on the topic of 'Remote Sensing of Snow' throughout the performance period. Cherry also gave a seminar on this topic to the graduate students and faculty in the Water Resources group at the UAF Civil Engineering department, as well as to a group of general public aerospace enthusiasts. Tedesche went on to be awarded a NASA student fellowship based on work she started under the GOES-R proving ground program support.

On June 16, 2016, science liaison Carl Dierking represented the satellite proving ground at an open house hosted by NWS forecast office Juneau. Carl spoke with the public about the new generation of weather satellites and what they mean to Alaska.

Science liaison Eric Stevens worked with forecasters at the US Air Force's 17th Operational Weather Squadron (OWS) in Hickam Air Force Base, Honolulu, Hawaii. Forecasters at the 17th OWS have responsibility for the USAF's aviation forecasts and pilot briefings in Alaska, and Eric gave a series of presentations on the use of satellite imagery in the production of aviation forecasts in Alaska. Staff from the 17th OWS and Eric also discussed opportunities for collaboration in the future between the USAF and the satellite proving ground.

Dr. Evan Ellicott visited Fairbanks in July. Dr. Ellicott of the University of Maryland traveled to Fairbanks to work with staff at Alaska Fire Service and GINA to streamline the use of GINA's direct broadcast data in generating imagery and products to support fire weather analysis and forecasting.

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Publications

None to report at this time.

Conference presentations

Cherry, J.E., 2016: Recent Airborne Remote Sensing of Snow, Ice and water in Alaska. *Eastern Snow Conference 2016,* Columbus, OH (Oral Presentation, June).

Cherry, J.E., 2016: Recent Airborne Remote Sensing of Snow, Ice and water in Alaska. *University of Alaska Fairbanks Water and Environment Research Center Seminar,* Fairbanks, AK (Oral Presentation, September).

Cherry, J.E., 2016: Airborne Science in Alaska. *Interior Alaska Chapter Experimental Aircraft Association,* North Pole, AK (Oral Presentation, July).

Dierking, C. 2016. Government and Academic Remote Sensing Partnerships for Near-Real-Time Support for US National Weather Service. EUMETSAT Satellite Conference in Darmstadt, Germany, September 2016.

Dierking, C. 2016. Remote Sensing Support for the National Weather Service's Alaska Sea Ice Program. EUMETSAT Satellite Conference in Darmstadt, Germany, September 2016.

Stevens, E. 2016. The Whole is Greater than the Parts: Client-Side Multi-Spectral Imagery in Alaska. Proving Ground User Readiness in Norman, Oklahoma, May 2016.

Zhu, J. 2017. Hybrid EnKF-3DVAR Data Assimilation Improves Alaska Short-term Forecasts, Poster presentation at American Meteorological Society Annual Meeting in Seattle, Washington, January 2017.

Other products and outcomes

Cherry was a finalist (top 100) again for the NASA Astronaut selection process. She described her work with the GOES-R Proving Ground program during the interview with the selection board at Johnson Space Center in October 2016.

Visiting scientists hosted: Sanmei Li of George Mason University visited in April 2016 to observe Yukon River breakup and validate her satellite derived flooding products. Amanda Terborg of the Aviation Weather Center visited in May 2016 and January 2017 to work with AAWU and CWSU aviation forecasters. Evan Ellicott of the University of Maryland visited in August 2016 to work with GINA and the Alaska Fire Service on satellite wildfire products. Kathy Strabala and Jordan Gerth visited in August 2016 to work with GINA on satellite data processing and to interview NWS WFO staff. Lori Schultz and Kevin McGrath of NASA SPoRT visited in September 2017 to work on AWIPS client side RGB and NUCAPS with GINA and the NWS WFOs. Michael Folmer of the Ocean Prediction Center visited GINA and the Alaska WFOs in March 2017 to work on multispectral oceanic products.

River Ice and Flooding Imitative - Visit to Alaska During Breakup

Jessica Cherry, PI ***CIFAR theme: Climate Change and Variability***
University of Alaska Fairbanks

Other investigators/professionals associated with this project:
Sanmei Li, George Mason University

NOAA Goal: Climate Adaption and Mitigation

Amendment: 53 NOAA Office: NESDIS, Mitch Goldberg, Sponsor
Budget Amounts: Cumulative $7,693, This year $7,693 (Amendment 53)
This project is new and closed.

Primary objectives

The primary objective of the visit was for co-lead scientist, Sanmei Li, who helped create the river ice and flooding product, to observe spring breakup of the Yukon River. Dr. Li was to compare the results of her algorithm's output to observations made from a small airplane. This product is sponsored through a JPSS program initiative and getting the leading scientist out in the field to observe breakup first hand was the primary objective.

Research accomplishments/highlights/findings

Supported visiting researcher Sanmei Li to observe Alaska spring river breakup.

Dr. Li met with National Weather Service (NWS) and UAF Geographic Information Network of Alaska (GINA) staff in Fairbanks to discuss the use of her river ice and flooding satellite-derived product during spring breakup in Alaska. Dr. Li also gave a presentation to the broader University of Alaska community. GINA's chief scientist, commercially-rated pilot, and hydro-meteorologist, Jessica Cherry, conducted an airborne survey of the upper Yukon River with Dr. Li, giving Dr. Li her first in-person view of Alaska's rivers during the spring melting season (figure 1). Dr. Li also met with hydrologists and forecasters working with the NWS in Anchorage. During the spring of 2017 Dr. Li's river ice and flooding product was processed using VIIRS satellite data captured via direct readout by GINA. The products were routinely imported into the University of Wisconsin's Real Earth web application. Products were also delivered to NWS forecasters and hydrologists as products usable in their desktop forecasting software, Advanced Weather Interactive Processing System (AWIPS). Figures 2a and 2b show both Dr. Li's river ice and flooding product. Figures 2b and 3 show high resolution orthoimagery captured and processed by Dr. Cherry's along the Yukon River with the satellite product overlaid.

Figure 1: Stretches of the Yukon River in Alaska's eastern Interior, late April 2016. Photo credit: Sanmei Li. GINA Chief Scientist Jessica Cherry piloted the plane during this survey of the rivers.

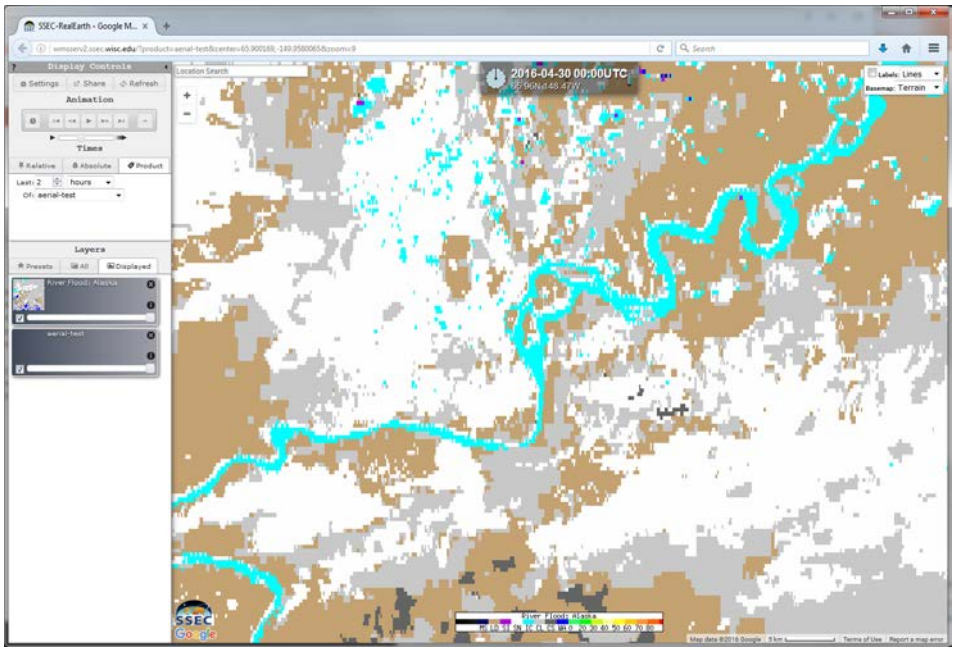

Figure 2a: Real Earth display of JPSS initiative's river ice and flooding product processed from VIIRS data captured by GINA in Fairbanks via direct broadcast. Area displayed is a portion of the Yukon River over Alaska's Interior in late April 2016.

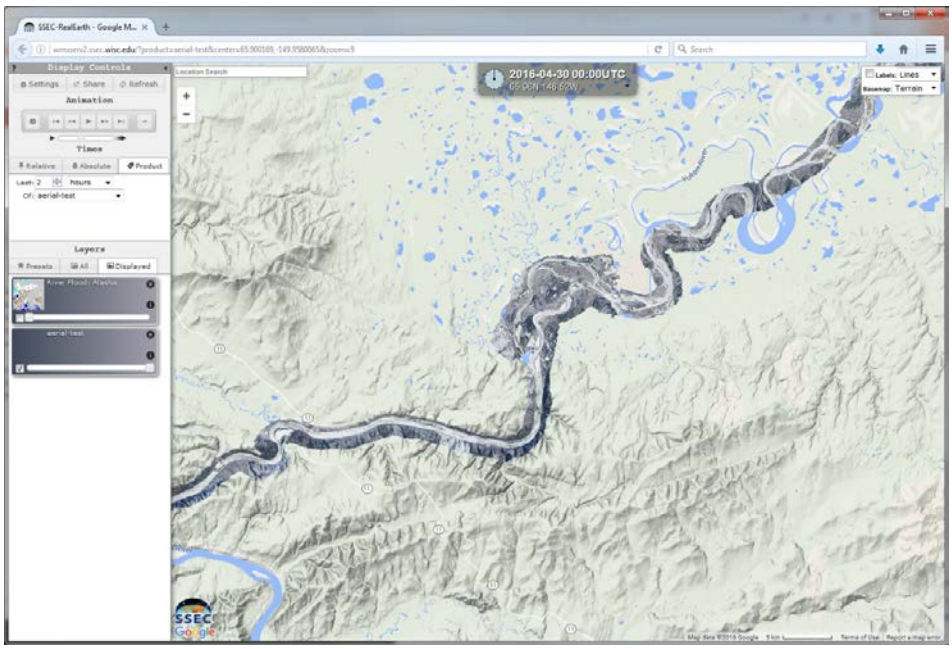

Figure 2b: Real Earth display of images over the Yukon River taken by GINA Chief Scientist Jessica Cherry. The time and location of this imagery taken from a low-flying aircraft corresponds to the VIIRS-based imagery shown in Figure 2.

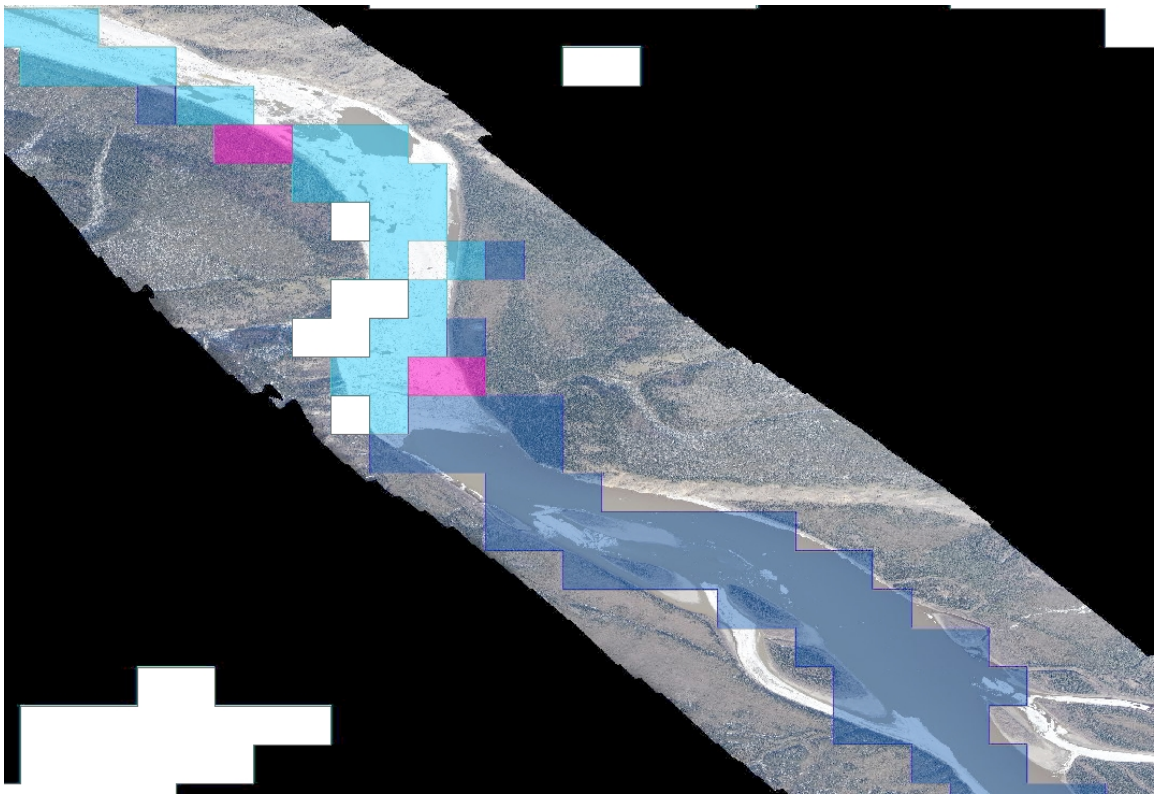

Figure 3: A comparison with the JPSS Proving ground VIIRS satellite based river ice product and Yukon river aerial imagery. Dark blue pixels are open water; light blue are ice; magenta are mixed water and ice.

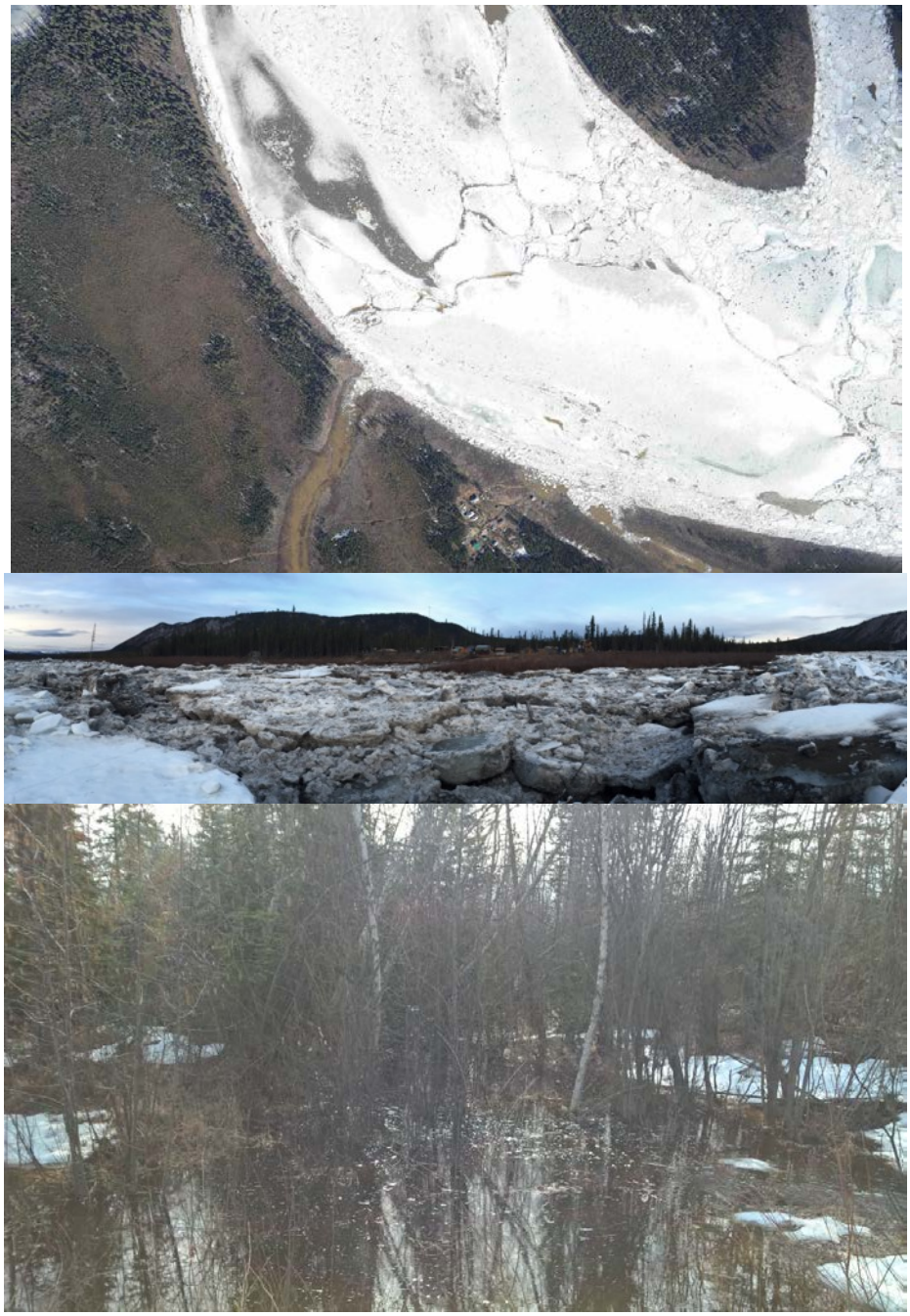

Figure 4: An ice jam causing minor flooding near Yukon River village of Eagle, Alaska. Top photos taken during April 2016 flood monitoring flights. Lower photos taken by an Eagle resident.

NOAA relevance/societal benefits

Flooding caused by ice jams damming a river during spring breakup is a major hazard for communities along Alaska's rivers. Many of the most destructive floods in Alaska history were caused by ice jams. Being able to monitory large reaches of river using satellite data gives NWS forecasters and hydrologists valuable information for issuing warnings and forecasts. Without satellite observations hydrologists must rely upon observations of very limited spatial extent, such as observers on the river bank and small aircraft flights. For scale, more than 1200 miles of the Yukon River is in Alaska and it is just one of dozens of rivers subject to ice jam flooding.

Partner organizations and collaborators

GINA, the NWS Alaska Pacific River Forecast Center, George Mason University, and the JPSS Program office have collaborated closely on this project.

Outreach

Dr. Li gave a public seminar at the University of Alaska Fairbanks during her visit to Alaska titled: Automatic Near Real-time Flood Mapping using SNPP/VIIRS Imagery.

Publications

None.

Conference presentations

None.

Other products and outcomes

None.

Gulf of Alaska Integrated Ecosystem Assessment Postdoctoral Research

Gordon H. Kruse, PI ***CIFAR theme: Climate Change and Variability***
University of Alaska Fairbanks

Other investigators/professionals associated with this project:
Kerim Aydin, National Marine Fisheries Service

NOAA Goal: Healthy Oceans

Amendment: 58 NOAA Office: NMFS, Jamal Moss, Sponsor
Budget Amounts: Cumulative $136,222, This year $136,222 (Amendment 58)
This project is new, and it is on a no-cost extension until 09/30/2017.

Primary objectives

Primary duties of the post-doctoral researcher will involve: (1) developing a conceptual model, or series of models that emulate the major ecological functions of the GOA; (2) an overarching Gulf of Alaska-wide plan for the Alaska IEA Program; and (3) the drafting of a proposal for a regional IEA specific to Southeast Alaska. Additional analyses will focus on determining which data are the most useful for ecosystem indicators.

Research accomplishments/highlights/findings

The start of this project has been delayed owing to delays in transmission of funding from NOAA to UAF and delays establishing the position and recruitment owing to personnel changes in UAF Human Resources.

The hiring committee consists of Dr. Gordon Kruse (UAF), Dr. Jamal Moss (NMFS), and Dr. Kerim Aydin (NMFS). Preliminary and intermediate interview questions and reference check questions were developed and approved by UAF Human Resources in December 2016. The postdoctoral position was advertised with the American Fisheries Society Jobs Bulletin, Alaska Chapter American Fisheries Society, Fishery Science Listserv, and emails to colleagues with state and federal agencies and universities across North America with a closing date of January 31, 2017. Nine applicants have applied. Completed applications were provided to the hiring committee in February 2017. At the end of February, preliminary and intermediate review led to the selection of two applicants for interview, and the selection of two additional candidates who the committee wishes to put “on hold” pending the outcome of the interviews with the leading two candidates. On March 27, 2017, UAF Human Resources gave approval of our proposed interview plan. The hiring committee is currently setting up the interview schedule. We plan to make our selection in the coming weeks with an expected starting date for early summer 2017.

NOAA relevance/societal benefits

NOAA Fisheries has identified a need for ecosystem-based management to fully support 21st century stewardship of our oceans and coasts. Integrated Ecosystem Assessments (IEAs) are a next generation tool designed to incorporate ecological processes in decision making and transfer scientific knowledge to managers and stakeholders. When fully implemented, IEAs have the power to quantify ecosystem services and feed into Management Strategy Evaluations (MSEs).

Partner organizations and collaborators

This project will involve collaboration with fisheries oceanographers, stock assessment scientists, ecosystem modelers, natural resource economists, commercial fishermen's organizations, tribal entities, and non-profit research organizations.

Impact

Results from this project will provide strategic guidance on management of federally managed fisheries in the Gulf of Alaska. Since the 1980s, fishery managers have been advised to move away from single-species management toward ecosystem-based fisheries management. Marine resources in the Gulf of Alaska support a wide variety of ecosystem services in addition to provisioning services in the form of fishery landings and seafood products. Integrated ecosystem assessments provide an efficient means to summarize the status of ecosystem components and provide a framework to screen and prioritize potential risks and evaluate alternative management strategies (i.e., management strategy evaluations), including evaluate tradeoffs in ecosystem services.

Education

The project will be primarily conducted by a postdoctoral researcher.

Outreach

Once the postdoctoral researcher starts, this project will involve substantial outreach with commercial fishermen's organizations, tribal entities, and non-profit research organizations. An initial focal area for this outreach will be Sitka, Alaska.

Publications

None.

Conference presentations

None.

Other products and outcomes

None.

Validation of GOES-R volcanic ash products: near real-time operational decision support/hazard analysis

Peter Webley, PI ***CIFAR theme: Coastal Hazards***
Martin Stuefer, Co-PI
University of Alaska Fairbanks

Other investigators/professionals funded by this project:
Jonathan Dehn, Stephen McNutt, co-PIs, University of Alaska Fairbanks [Since left UAF]

NOAA Goal: Weather Ready Nation

Amendments: 9, 17 NOAA Office: NESDIS, Andrew Heidinger, Sponsor
Budget Amounts: Cumulative $191,770, This year $0
This project is complete.

Primary objectives

- Produce a Weather Research & Forecasting (WRF)-Chem/Puff model-satellite comparison product for operations.
- Provide a confirmation and an assessment of Geostationary Operational Environmental Satellite – R Series (GOES-R) derived ash cloud detections and heights.
- Determine the full particle size distribution and total mass and relate to retrieved GOES-R products.
- Support development of an improved operational volcanic ash tracking product to NWS for use in Alaska and farther afield.

Research Accomplishments/highlights

In the past year we have completed our comparisons between satellite-derived volcanic ash retrievals and the WRF-Chem volcanic ash transport model. Our aim was to transition between this research project and the follow on project that will continue to use the WRF-Chem model and build more real-time products. Our work in our final year focused on how to perform model simulations quickly using both Lagrangian models, such as HYSPLIT or Puff, and Eulerian models, WRF-Chem. As the project came to an end then we began winding down the research being performed.

NOAA relevance/societal benefits

GOES-R is a key element in NOAA's ongoing satellite series. We provided a confirmation, validation and assessment of one of the GOES-R baseline products. We provided tools to better understand the outputs of effective particle size, volcanic ash mass, and cloud height from the volcanic ash cloud detection and height algorithm. Volcanic ash clouds are a severe event and can cause serious damage to aircraft, cause airport closures and affect human health. This project aimed to provide improved hazard assessment and reduce the potential risk from volcanic eruptions.

Education

Sean Egan, Ph.D. student in Environmental Chemistry. Role on Project: Comparison of WRF-Chem SO2 and ash simulations to satellite based retrievals using UV and thermal infrared (TIR) data, including ASTER (Advanced Spaceborne Thermal Emission & Reflection), MODIS (Moderate Resolution Imaging Spectroradiometer), OMI and AIRS (Atmospheric Infrared Sounder) data. Sean's work transitioned into the follow-on project [PI Martin Stuefer, GOES-R RAP, amendment 21 to this cooperative agreement].

Martin C. Harrild, MSc. Student in Geology and Geophysics. Role on the Project: Early detection of volcanic events in real-time ground observations to instigate WRF-Chem real-time simulations for active volcanoes. Martin worked with ground-based webcams and comparing the data to satellite imagery for the every detection of events.

This work lead into the follow-on project [PI Martin Stuefer, GOES-R RAP, amendment 21 to this cooperative agreement] of integrating the WRF-Chem model into the Rapid Refresh (RAP), the continental-scale NOAA hourly updated assimilation/modeling system operational at the National Center for Environmental Prediction (NCEP)

Outreach:

Not applicable.

Publications and presentations

Not applicable.

Other products and outcomes

Not applicable.

Partner organizations and collaborators

- Jeff Osiensky (NWS Volcanic Ash Program Manager), NWS Alaska Region, Anchorage, Alaska.
- Michael Pavolonis (GOES-R Volcanic Ash Algorithm Developer), NOAA Center for Satellite Applications and Research, Advanced Satellite Products Branch, Madison, Wisconsin.
- Kristine Nelson (Meteorologist in Charge), Center Weather Service Unit, NWS, Anchorage, Alaska.
- Georg A. Grell (Leads development for inline WRF-chemistry model and WRF-Chem working group), NOAA Earth Systems Research Laboratory, Boulder, Colorado.
- Saulo Freitas (Development of the plume emission module in WRF-Chem and collaborator on forest fire and volcanic cloud modeling with WRF-Chem), Centro de Previsão de Tempo e Estudos Climáticos (CPTEC – INPE), Brazil.

Impact

The work developed under this project highlighted the need to integrate the dispersion modeling from WRF-Chem with the volcanic ash retrievals, and that observational data is critical in constraining the modeling results and re-evaluating the model inputs used for the initial modeling simulations. The work performed in our project led to the proposed and then approved project led by Stuefer and Webley,

entitled “GOES-R volcanic ash risk reduction: Operational decision support with NOAA’s Rapid Refresh (RAP).Together the modeling and retrievals can provide the NWS and NOAA with the necessary tools to provide volcanic ash advisories through their Washington and Anchorage Volcanic Ash Advisory Centers (VAAC).

GOES-R Volcanic Ash Risk Reduction: Operational decision support within NOAA's Rapid Refresh (RAP)

Martin Stuefer, PI ***CIFAR theme: Coastal Hazards***
Peter Webley, Co-PI
University of Alaska Fairbanks

Other investigators/professionals associated with this project (w/affiliation):
Georg Grell, NOAA Earth Systems Research Laboratory
Michael J Pavolonis, NOAA/NESDIS Center for Satellite Applications and Research (STAR)

NOAA Goal: Weather Ready Nation

Amendments: 21, 37 NOAA Office: NESDIS, Andrew Heidinger, Sponsor
Budget Amounts: Cumulative $196,364, This year $0
This project is on a no cost extension until 08/31/2017.

Primary objectives

Evaluate the GOES-R Advanced Baseline Imager (ABI) Volcanic Ash Algorithm (VAA) baseline product with case studies using the Weather Research Forecasting model with inline Chemistry (WRF-Chem), and to provide pathways to implement the ABI VAA in NOAA's operational Rapid Refresh modeling system. The work aims to improve NWS operational numerical weather prediction capabilities for aviation hazard support.

Research Accomplishments/highlights

- WRF-Chem case studies have been completed with historic eruption source parameters. The data are available for comparison with the GOES-R equivalent ash retrievals from MODIS data.
- An ash aggregation scheme has been implemented and is within an evaluation process. The WRF-Chem source code has been modified to test the aggregation parameterization.
- The pathway to implement volcanic ash within the RAP model was outlined in coordination with our colleagues from NOAA/ESRL. The RAP model fields were extended to a 36-hour prediction time period at NOAA/ESRL. The modelling code was adapted to the latest WRF-Chem version. The code is ready for RAP model implementation.
- The near-real time WRF-Chem runs were further tested on a daily basis. Volcanic ash alerts were implemented in scripts triggering a routine to create a WRF modelling domain and all WRF-Chem pre-processing files; the routine consequently initiates the WRF-Chem model run.
- An ash aggregation scheme has been implemented in WRF-Chem and model analysis was performed using the Eyjafjallajökull test case. The WRF-Chem source code has been modified to test the aggregation parameterization. An improvement of predicted ash concentrations was found for the Eyjafjallajökull case (Figure 1).
- Observational data were compiled, and ash baseline products collected and re-ordered.
- The implementation of the volcanic ash plume parameterization within the RAP model is in progress and will be realized within the experimental high-resolution runs of RAP in collaboration with our collaborator Georg Grell from NOAA/ESRL. Trevor Alcott and possibly Georg Grell are working with us

the University of Alaska Fairbanks (UAF) to collaboratively perform the RAP implementation work. The volcanic ash emission module has been updated and made available for RAP. We performed benchmark tests to evaluate the added computing time.

- Near real time volcanic ash alerts using WRF-Chem and RAP are available. Graphical capabilities have been developed. Work is in progress to modify the WRF-Chem volcanic ash code to run the model with a number of 10 fine ash-bins erupted at different heights within the same and identical model run. This effort will account for near real-time forecasts of 'negative ash' areas, which are valuable for airline route planning purposes while near real-time volcanic eruptions occur.
- WRF-Chem case studies with aerosol aware microphysics and radiation parameterization schemes have been performed for the eruption of Eyjafjallajökull volcano in Iceland in spring 2010. The model results show excellent coincidence with ash particle concentration measurements performed over Europe (Figure 2).

Model Development: The volcanic ash emission driver has been modified to account for the actual vent height of a volcano instead of the height of the model terrain at the gridcell of the respective volcano. Differences in the volcanic plume have been identified due to various vent heights for the Eyjafjallajökull case. Further modification include experiments with the initial plume parameterization during an event.

Near Real-Time WRF-Chem runs: A scheme to run the WRF-Chem volcanic ash cloud dispersion model in an operational-like setting has been developed. Volcanic activity alerts from the U.S. Geological Survey (USGS) Volcano Notification Service (VNS) (http://volcanoes.usgs.gov/vns) occur almost daily, and we have been running WRF-Chem volcanic ash predictions for the 'color coded' volcanoes daily. The WRF-Chem runs are initialized with default volcanic eruption source parameters. Work is in progress to develop a more versatile model initialization tool in order to use GOES-R volcanic baseline products to realistically initialize the RAP model with GOES-R baseline products. We tested options to initialize WRF-Chem with RAP, and plan to run RAP-WRF-Chem in near-real time daily or whenever activity alerts are present.

NOAA relevance/societal benefits:

GOES-R is a key element in NOAA's ongoing satellite series. We will provide a confirmation, validation and assessment of one of the GOES-R baseline products. We will provide tools to better understand the outputs of effective particle size, volcanic ash mass and height from the volcanic ash cloud detection and height algorithm.

Volcanic ash clouds are a severe event and can cause serious damage to aircraft, cause airport closures and affect human health. This project aims to provide improved hazard assessment and reduce the potential risk from volcanic eruptions. The GOES-R high temporal resolution in combination with the Rapid Refresh (RAP) model will allow for a timely volcanic ash hazard awareness and dissemination of volcanic warnings.

Education

Sean Egan is a Ph.D. candidate student in Environmental Chemistry at UAF working within this project.

Marcus Hirtl is a Ph.D. candidate student within the Interdisciplinary Program at UAF working on this project.

Publications and presentations

S. Egan, M. Stuefer, P. Webley, and C. Cahill, "WRF-Chem modeling of sulfur dioxide emissions from the 2008 Kasatochi Volcano," *Ann. Geophys.*, vol. 57, no. 0, 2015.

Stuefer, M., Freitas, S. R., Grell, G., Webley, P., Peckham, S., McKeen, S. A., & Egan, S. D. (2013). Inclusion of ash and SO2 emissions from volcanic eruptions in WRF-Chem: development and some applications. *Geoscientific. Model Development*, 6(2), 457–468.

Stuefer, M., G., Egan, S. D., Webley, P., Freitas, S. R., Grell G.: Volcanic WRF-Chem Model Application Updates. *Invited Poster presentation at the 7th International Workshop on Volcanic Ash*; October 2015, Anchorage.

Hirtl M., M. Stuefer, D. Arnold, C. Flandorfer, C. Maurer, S. Natali, B. Scherllin-Pirscher: The influence of the direct- and semi-direct effect on the weather conditions in Europe caused by the volcanic ash plume of the Eyjafjallajökull eruption during April and May 2010 with WRF-Chem. *European Geosciences Union, General Assembly 2017, Austria, Vienna, 24h – 28nd April 2017*

Impact, Other products and outcomes

Knowledge of the location and amount of volcanic ash is critical for NOAA and the NWS in their role to maintain the Anchorage and Washington Volcanic Ash Advisory Centers (VAAC). Satellite data from any volcanic ash algorithm, including the GOES-R products, can only determine the ash cloud location and mass loadings at one instant in time. Our work in this project analyzes the ash products from satellite data with products from volcanic ash transport and dispersion models.

We have highlighted the significance of the input parameters to the downwind concentrations and how this affects the mass loadings that are compared to the volcanic ash products. Additionally, we have shown how the cloud and plume top measurements from satellite data require both knowledge of the timing of the measurement as well as optical depth if they are to be used for the true cloud top height.

Improved tools to compare the volcanic ash products from the satellite data to the Volcanic Ash Transport and Dispersion (VATD) models will benefit the NWS in Alaska as they will be able to use them in their duties in the VAAC and in the production of their volcanic ash advisories. The tools and analysis in this project can be applied directly to all VAAC offices and Alaska Meteorological Watch Office and Alaska Aviation Weather Unit.

Partner organizations and collaborators

Georg Grell, NOAA Earth Systems Research Laboratory

Michael J Pavolonis, NOAA/NESDIS Center for Satellite Applications and Research (STAR)

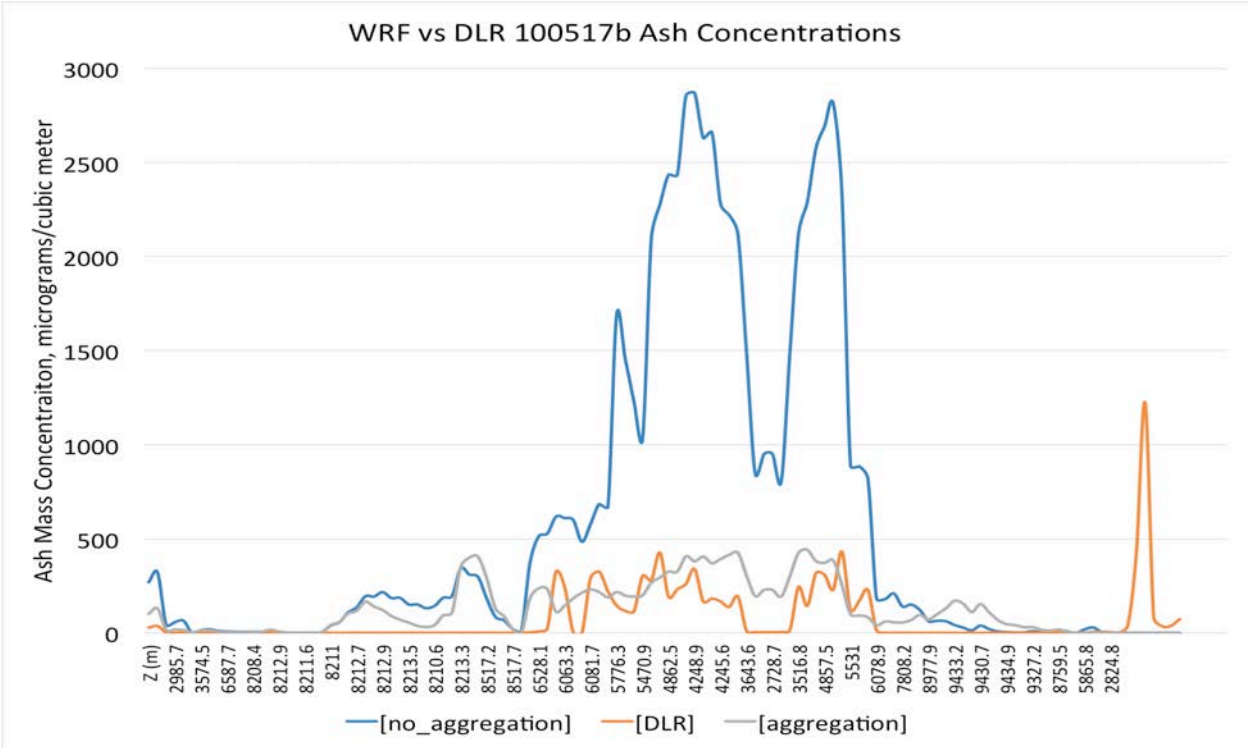

Figure 1: WRF-Chem modeled Eyjafjallajökull ash concentration for 17 May 2010 compared with in-situ volcanic ash measurements performed by the DLR-Falcon aircraft (orange line). The blue and grey lines indicate modeled concentrations without (blue) and with modeled (grey) ash particle aggregation.

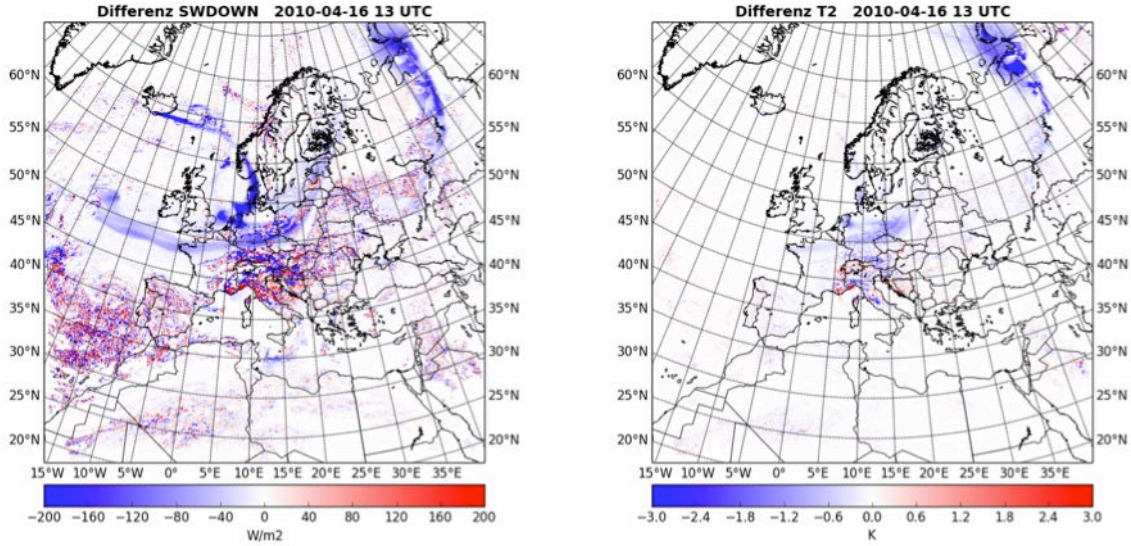

Figure 2: Radiation and temperature feedback to volcanic ash as modeled by WRF-Chem for the Eyjafjallajökull eruption from April 16, 2010. The difference (with versus without volcanic ash-plume) is shown for the down-welling shortwave radiation (left) and for the near surface temperature (right). Figure by M. Hirtl.

Alaska Earthquake Center seismic station operations and maintenance

Michael West, PI ***CIFAR theme: Coastal Hazards***
Natalia Ruppert, Co-PI
University of Alaska Fairbanks

Other investigators/professionals associated with this project (w/affiliation):
Miriam Braun, Scott Dalton, Ian Dickson, Dara Merz, Sara Meyer, Natalia Kozyreva, Mitch Robinson
University of Alaska Fairbanks

NOAA Goal: Weather Ready Nation

Amendments: 7, 26, 41, 61 NOAA Office: NWS, Michael Angove, Sponsor
Budget Amounts: Cumulative $854,981, This year $240,000 (Amendment 61)
This project is set to end 09/30/2017.

Primary objectives

- Maintain NOAA-funded seismic stations in the integrated Alaska Seismic Network
- Upgrade analog stations to Advanced National Seismic System (ANSS) standards of modern broadband equipment.
- Locate seismic events occurring in Alaska and produce alarms and warnings to the National Tsunami Warning Center (NTWC) and emergency managers.
- Maintain data flow of selected stations to NTWC

Research Accomplishments/highlights

The average data return rate for the 17 NOAA-funded seismic stations was 93% during this reporting period. Excluding DCPH, which remains out of service due to ongoing discussions with USCG regarding site co-location. This data return metric is 4% worse than in the previous reporting period, but better than for FY14. Four sites had average return rates less than 90% for the reporting period. Two sites, in Atka (ATKA) and False Pass (FALS), experienced prolonged outages related to the networking and router issues. Infrastructure at the site in Gambell (GAMB) was damaged during strong winter storms. The site remained intermittent until we were able to get to the site in April 2017. One site in the Chugach Mountains (BMR) failed in February due to insufficient power. We had scheduled to replace batteries at this site in summer of 2016 but were unable to do it due to marginal weather during the scheduled maintenance trip. We were unable to schedule another site visit due to lack of funding for helicopter support (it is a remote site with helicopter access only).

Between April 1, 2016 and March 31, 2017, the Alaska Earthquake Center (AEC) reported 37,527 events with magnitudes ranging between -1.0 and 6.2 and depths between 0 and 291 km (Figure 1). Three earthquakes had magnitudes of 6 or greater. The two largest earthquakes, of magnitude 6.2, occurred on April 2, 2016 in the Alaska Peninsula region and on March 27, 2017 in the Near Islands, Aleutian Islands.

The seismic instruments and dataloggers at several NOAA-funded sites are approaching fifteen years in the field, and we are not budgeted for replacements. While several sites have benefitted from EarthScope- or AEC-provided instruments, other NOAA-funded sites will require additional funding to replace aging equipment.

During the reporting period, we visited 9 NOAA-funded sites and performed the following work:

- ATKA (Atka) July 8-10, 2016 – moved receive site from Health Clinic (was scheduled for demolition) to the new City Office Building; we had to establish new networking protocols, which later caused problems and resulted in an outage. Remote troubleshooting continued in the fall. We scheduled a site visit in January, but our engineer was grounded in Dutch Harbor for nearly 2 weeks, due to bad weather and the Bogoslof volcano eruption, and was unable to reach Atka. Another site visit is scheduled for the week of April 17, 2017.
- BMR (Bremner, Chugach Mountains) – this site was scheduled for battery replacement in summer of 2016. However, we were unable to get to the site due to bad weather during the scheduled trip. We were unable to schedule another site visit due to lack of funding for helicopter support (it is a remote site with helicopter access only).
- COLD (Coldfoot) August 10-11, 2016 – relocated site to a new location due to DOT work at the quarry in close proximity to the seismic site. The new location has a diminished line of sight to the data receive facility. As a result it experienced intermittent multi-hour outages during the winter. We plan to improve telemetry during 2017 field work.
- DCPH (Deception Hills) – continued discussions with USCG regarding equipment co-location and license agreement paperwork. No site visit in 2016.
- DOT (Dot Lake) July 16, 2016 – troubleshooting outage that was due to a bad port on the router.
- EYAK (Eyak Ski Hill, Cordova) May 20, 2016 – replaced UPS battery.
- FALS (False Pass) August 23-24, 2016 – replaced 15-year-old broadband and strong motion sensors with new sensors, troubleshoot network related outage.
- GAMB (Gambell) April 3-5, 2016 - troubleshoot outage by replacing external antenna at the receive site in school.
- NIKH (Nikolski) – a battery swap is scheduled for the week of April 10, 2017; new batteries were purchased in 2016 and shipped to Nikolski.
- PAX (Paxon Lake) July 21, 2016 – troubleshoot outage by replacing CSU/DSU card in the router.
- PIN (Pinnacle, Yakutat Bay area) August 4, 2016 – replaced power controller and cellair batteries.
- SWD (Seward) August 25-29, 2016 – replaced 15-year-old Guralp broadband sensor with new Trillium Posthole sensor, upgraded wiring and other infrastructure.

NOAA relevance/societal benefits

- Improved detection of tsunamigenic earthquakes by the NOAA tsunami warning centers and the Alaska Earthquake Center.
- Creation of earthquake knowledge that informs tsunami inundation modeling under NOAA's NTHMP program.

Outreach

AEC continues to provide real-time and reviewed earthquake information to local emergency service offices and to the public. The primary means for this is the Earthquake Center website, earthquake.alaska.edu. The support and collaboration with NOAA is reiterated in several places across the site.

While not an explicit part of this project, the earthquake catalog shown in Figure 1 is critical information used in the development of the tsunami inundation hazard products.

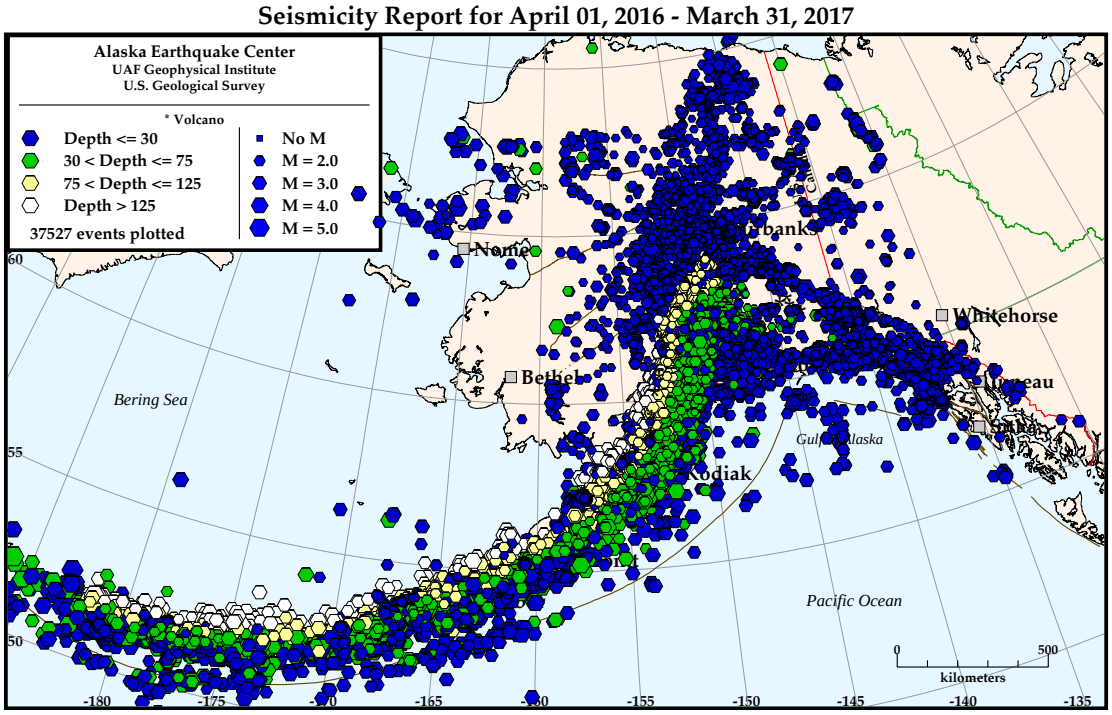

Figure 1. Events located from April 1, 2016 through March 31, 2017.

Supporting NOAA's mission goals using unmanned aircraft systems (UAS) technology

Greg Walker, PI ***CIFAR themes: Coastal Hazards; Ecosystem Studies and Forecasting***
Marty Rogers, PI (as of 3/1/14)
University of Alaska Fairbanks

NOAA Goals: Healthy Oceans; Weather Ready Nation

Amendment: 11 NOAA Office: OAR, Robbie Hood, Sponsor
Budget Amounts: Cumulative $129,165, This year $0
This project is complete.

Primary objectives

The main science objective of this project is to use two different UAS to meet NOAA's mission goals in three areas.

1. **Survey of marine debris generated by the 2011 Japanese tsunami**. We plan to search and map the location, type, distribution and movement of marine debris originating from the tsunami that struck Japan on March 11, 2011.
2. **Arctic Ocean and sea ice engineering system development tests**. In coordination with the NASA funded UAS project "Marginal Ice Zone Observations and Processes Experiment (MIZOPEX)" we plan to conduct UAS field trials from Oliktok Point, Alaska.
3. **Augment existing Steller sea lion research project with field time**. This project will supplement and continue the technology evaluation underway to evaluate augmenting current Steller sea lion surveys with UAS.

Research accomplishments/highlights/findings

Survey of marine debris generated by the 2011 Japanese tsunami - Under this effort, managed a subcontractor, Airborne Technologies, Inc. (ATI) of Wasilla, Alaska in their preparation of the Resolution sUAS that they have designed and built under a NOAA Small Business Innovation Research (SBIR) contract.

Phase 5 (Final Mission) – Channel Islands Field Program (July 2014 – December 2014)
Description - Upon successful completion of the Avon Park Demonstration in June 2014, preparations were made for the final field program of the project, a two-day cruise on the Channel Islands National Marine Sanctuary R/V Shearwater out of Santa Barbara, California harbor. Only flights of the Resolution were scheduled since the Puma already had a number of marine debris flights both within this project and within other projects. Required documents were prepared and sent to Matthew Nardi of AOC. AOC sought and received an FAA COA, frequency approval, and approval of the Commanding Officer AOC for the mission. A Flight Readiness Review was held on November 17 and final approvals were received just prior to the flights on December 5. Artificial targets were collected and stored on the Shearwater to be ready for the cruise on December 8 and 9. High-resolution multispectral visible satellite data were scheduled for just before and during the cruise. Matthew Nardi contacted the FAA to issue a NOTAM, and local helicopter and flightseeing companies were advised of the UAS operations as was the Santa Barbara Airport, Point Mugu, and the Coast Guard. Participants in the cruise were:

1. William Pichel, NOAA/NESDIS/STAR/SOCD – Project Principal Investigator

2. Tim Veenstra, Airborne Technologies Inc. (ATI) – Developer of the Resolution-3 and Pilot in Charge
3. Rosanne Bailey - University of Alaska Fairbanks – Mission Coordinator
4. Curtis Olson – ATI – Resolution Supplemental Pilot and Operator
5. Todd Jacobs – NOAA Channel Islands National Marine Sanctuary (NMS) - Observer and Representative of NOAA UAS Program Office and Channel Islands NMS
6. Terrence Shinn – Captain of the R/V Shearwater
7. Charles Lara – First Mate of the R/V Shearwater
8. Elizabeth Mackie – NOAA Commissioned Corps – NOAA Shearwater Representative

On December 8, after loading aboard two Resolution aircraft, fire and abandon ship training were given by the Shearwater crew, and Rosanne Bailey led a briefing on the Resolution aircraft and safe operation. Weather and visibility were excellent and there were numerous natural surface targets (birds, kelp, porpoises and a whale). The Resolution was successfully launched from its catapult launcher and flew for 43 seconds. Then a random failure occurred in the servo controlling the left elevon. The aircraft rolled and dived into the water, damaging the wing on impact and the electronics after water entered the aircraft through the broken wing. It was determined that no more flights should be attempted with the backup aircraft until the problem was diagnosed. On December 9, an incident report was prepared for AOC and Matthew Nardi submitted it to the FAA. It was decided that the cause of the failure was not known sufficiently to consider another flight and probably would not have been approved by AOC in any case. The ATI crew briefed everyone on the ATI aircraft, launcher, and the image mosaicking and analysis software system. Artificial debris targets were returned to their source and the field program was concluded.

Results and Deliverables – Documents submitted to AOC and received from the FAA for the COA and from AOC for mission approval included:

1. CINMS Operation Risk Management Assessment ("2014 ATI Resolution 3 Marine Debris CINMS ORM Final-1.pdf")
2. CINMS Operations Plan ("Channel_Islands_Reslution_Field_Program_Ops_Pland_V5.docx")
3. CINMS Aircraft Support Form ("NOAA Form 57-11-51 Aircraft Support Request Form_UAS_survey _of_Japanese_Marine_Debris_Pichel_final_field_program-1_signed.pdf')
4. Resolution Technical Document ("Resolution Tech document.pdf")
5. UAS Flight Request Form ("UAS Flight Request – Resolution_Channel_Islands_NMS_4.pdf'")
6. COA ("121203_FAA Form 7711-1 2014-WSA-182 COA NOAA (Resolution) Channel Islands CA.pdf")
7. AOC Commanding Officer approval: (ATI_Resoltuion_COFltAuthorization_DEC_2014.pdf")

The ATI Resolution Pre-flight checklist was used during the Resolution launch preparations

Demonstration Flight Results

Below are representative images that were taken during the demonstration flights on June 6, 2014. The camera was set in manual mode with 1/1000 sec shutter speed, aperture of 6.3 and ISO at 400. While the images were acceptable with good exposure, results would have been improved with a slight increase in the aperture. The image histograms were skewed slightly to the right which results in washed out highlights. Generally, the settings are adjusted for the ground cover (water color, vegetation...) and objects that you intend to capture. In image #1 and #2, you will notice that the white sun tent and car are slightly washed out.

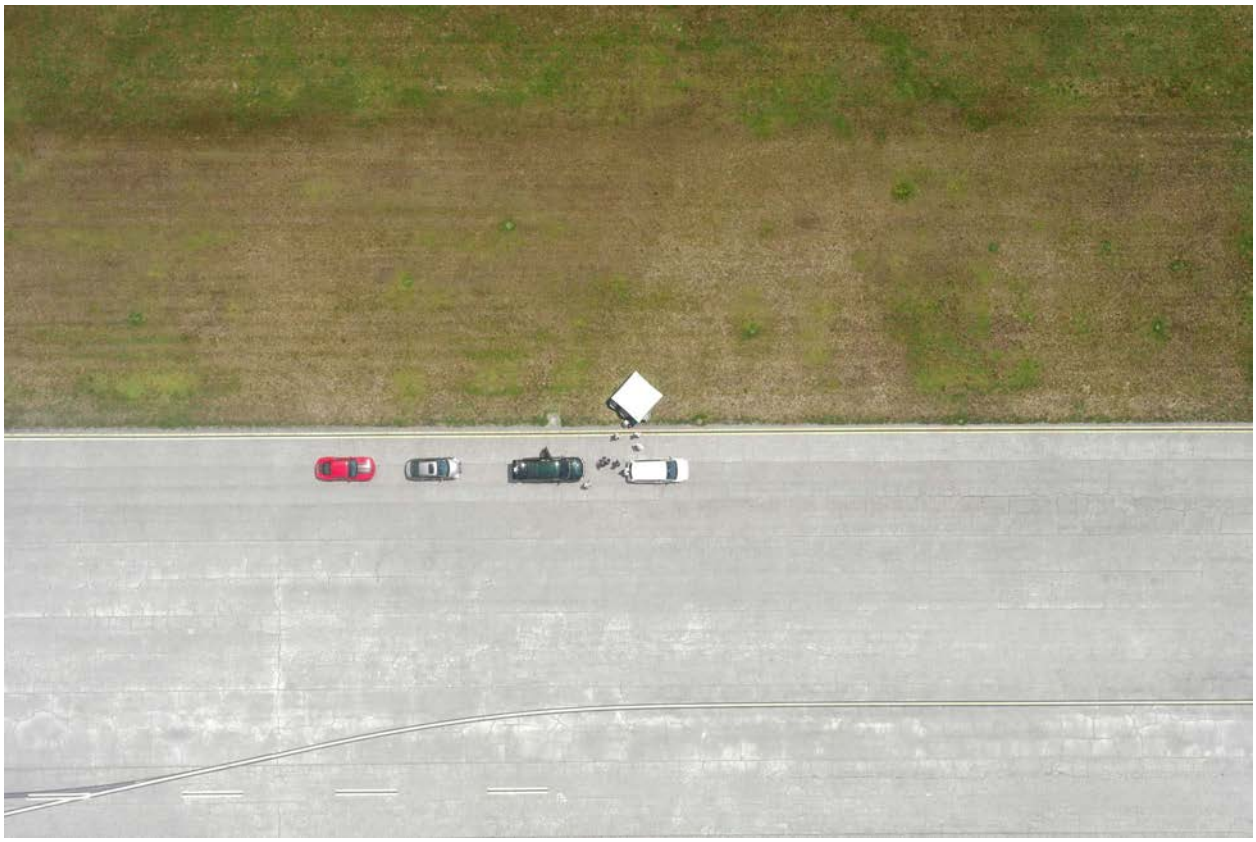

Illustration 1: Image #0083 of runway with vehicles and sun shelter

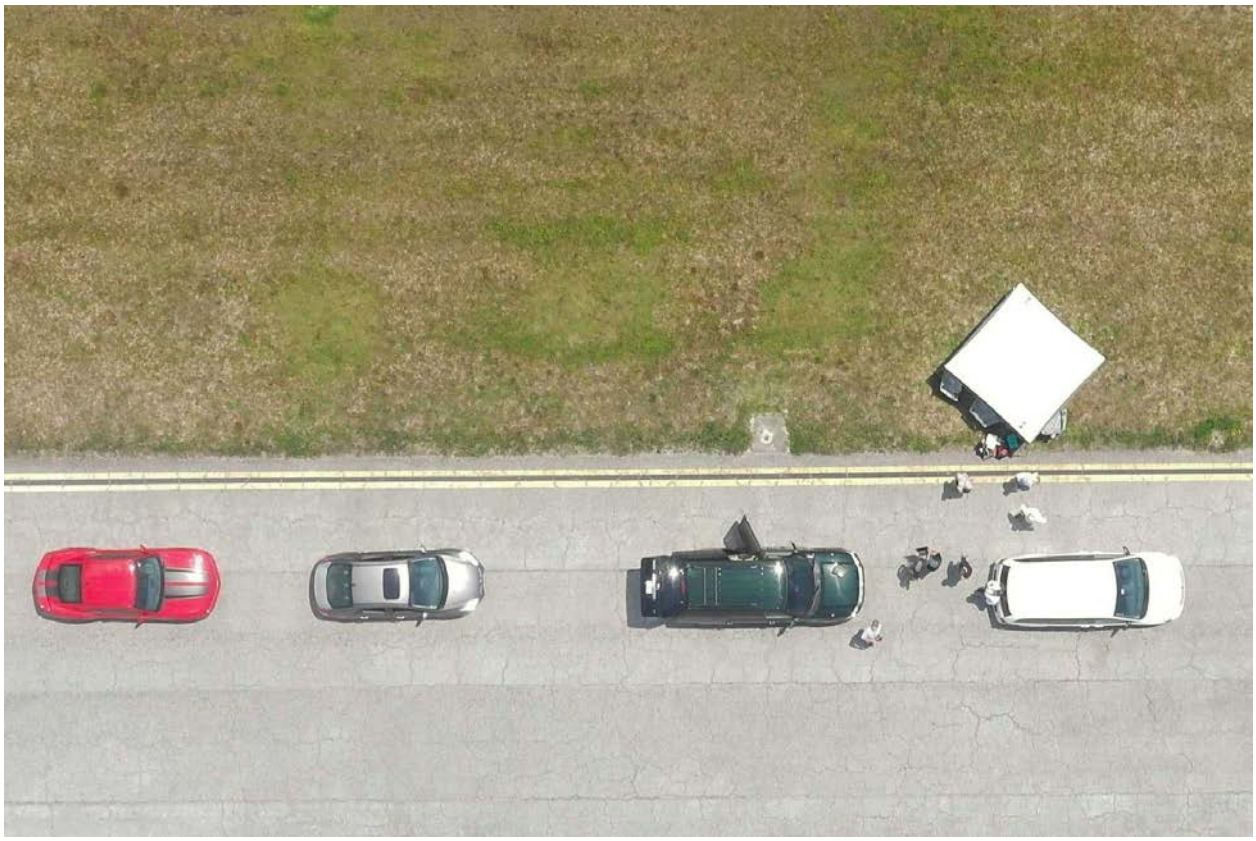

Illustration 2: Cropped view of image #0083 with 1.5 cm per pixel ground resolution

Illustration 3: In this enhanced crop of image #233, the red bungee cord used for launching the UAS is visible stretching across the grass and coiled up on the runway. The bungee cord is ½ inch in diameter.

Arctic Ocean and sea ice engineering system development tests – The UAF portion of 2013 MIZOPEX (Marginal Ice Zone Oceans and Ice Observations and Process Experiment) mission has been completed successfully.

Augment existing Steller sea lion research project with field time – The Steller sea lion (SSL) project has been completed successfully. (See previous reports)

NOAA relevance/societal benefits

We believe all three projects have extended the NOAA UAS capabilities and understanding of the sUAS potential for NOAA missions.

Partner organizations and collaborators

Columbia University
University of Colorado
Ball Aerospace
US Air Force Special Operations Command
AeroVironment Inc.
Airborne Technologies Inc.

Impact

The value of low-cost aerial imagery in remote locations in Alaska is profound. From managing endangered species, such as the Steller Sea Lions in the Western Aleutians to understanding the Marginal Ice Zone in the Arctic, this technology affords NOAA many new methods of understanding the environment that they must manage. Alaska is a challenging environment for these platforms and applications, and our research increases the understanding of this technology and identifying the existing limitations to realize fully their potential mission set.

Fish and fisheries research in the central Arctic Ocean

Franz Mueter, PI ***CIFAR theme: Climate Change and Variability***
University of Alaska Fairbanks

Other investigators/professionals associated with this project:
Jennifer Marsh, College of Fisheries and Ocean Sciences, UAF

NOAA Goal: Climate Adaptation and Mitigation

Amendment: 56 NOAA Office: NMFS, Phil Mundy, Sponsor
Budget Amounts: Cumulative $15,704, This year $15,704 (Amendment 56)
This project is new, and it is set to end 09/30/2017.

Primary objectives

Dr. Mueter worked with Dr. Phil Mundy at the Alaska Fisheries Science Center and with a Ph.D. student (Jen Marsh) to provide scientific support to the US delegation to the Fourth Meeting of scientific experts on fish stocks of the Central Arctic Ocean. The objectives of the project were twofold. First, to review and compile in an electronic bibliography relevant literature on Polar cod (*Boreogadus saida*) and other fishes documented to occur in the central Arctic Ocean and surrounding seas that may have ecological or commercial significance. Second, to write up what is known about the occurrence, distribution and abundance of fish and shellfish of the central Arctic Ocean and adjacent waters in *Synthesis of Knowledge on Fisheries Science in the Central Arctic Ocean.*

Research accomplishments/highlights/findings

The objectives of compiling an electronic bibliography and writing sections of the Synthesis of Knowledge were met. Specifically, references on Polar cod, Arctic cod (*Arctogadus glacialis*), Greenland halibut (*Reinhardtius hippoglossoides*) and Arctic skate (*Amblyraia hyperborea*) from the central Arctic Ocean, Northern Bering-Chukchi Seas, Beaufort Sea, East Siberian Sea, Canadian High Arctic-North, Greenland, Laptev Sea and Kara Sea were added to an EndNote electronic bibliography. Also, references on relevant stock assessment methods were added to the bibliography. Information was synthesized and written up in the Occurrence, distribution and abundance of fish and shellfish of the central Arctic Ocean and Adjacent Waters section of the *Synthesis of Knowledge on Fisheries Science in the Central Arctic Ocean.* Text on life history and geographic phenology of *B. saida* and *A. glacialis* was added to a later draft after the Fourth Meeting of Scientific Experts on Fish Stocks in the Central Arctic Ocean convened.

NOAA relevance/societal benefits

The focus of this project is to contribute to synthesis of what is known and unknown about fish stocks in the central Arctic Ocean and adjacent seas. The synthesis will help guide future research, management and conservation measures by the countries that are party to the including the Kingdom of Norway, the Russian Federation, the United States of America, Canada, and the Kingdom of Denmark, the People's Republic of China, the Republic of Korea, Japan, Iceland and the European Union.

Partner organizations and collaborators

The *Synthesis of Knowledge on Fisheries Science in the Central Arctic Ocean* was written in collaboration with Sunnanå Knut and Randi Ingvaldsen from the Norwegian Institute of Marine Research and Tayler

Jarvis of National Marine Fisheries Service. Data were contributed by Brenda Norcross at the University of Alaska Fairbanks, Libby Logerwell, Ed Farley, Ron Heintz, and Johanna Vollenweider at NOAA's Alaska Fisheries Science Center, Hein Rune Skjoldal and Harald Gjøsæter at the Institute of Marine Research, Norway, Olafur S. Astthorsson at the Marine Research Institute, Reykjavik, Iceland, and Kevin Hedges at UiT The Arctic University of Norway, Tromsø, Norway.

Impact

The report *Synthesis of Knowledge on Fisheries Science in the Central Arctic Ocean* was submitted to the Fourth Meeting of Scientific Experts on Fish Stocks in the Central Arctic Ocean. The report will be used to help identify research priorities and inform management and conservation of living marine resources in the Central Arctic Ocean.

Education

Not Applicable.

Outreach

Not Applicable.

Publications

Mundy, P. R., Sunnanå, K., Ingvaldsen, R., Marsh, J., Jarvis, T., Astthorsson, T., Hoel, A.H. (2017) *Synthesis of Knowledge on Fisheries Science in the Central Arctic* Fourth Meeting of Scientific Experts on Fish Stocks in the Central Arctic Ocean (4th FiSCAO), Tromso, Norway, September 26 - 28, 2016

Conference presentations

None to report at this time.

Other products and outcomes

None to report at this time.

APPENDIX 1 AWARDS THROUGH CIFAR 1 APRIL 2016-31 MARCH 2017

CIFAR Projects Awarded in Cooperative Agreement NA13OAR4320056
1 April 2016 to 31 March 2017

Last	First	Proposal Title	Amend	Project Budget	Theme Description	Funding Source	NOAA PM
Task 1 Activities: CI Administration and Education & Outreach							
Bhatt	**Uma**	Task I Request for S21897 - Hopcroft	46	$9,824	Administration	OAR	Mathis
Bhatt	**Uma**	Task I Request for S22304 - Heinrichs	50	$20,025	Administration	NESDIS	Goldberg
Bhatt	**Uma**	Task I Request for S22270 - Cross	55	$3,560	Administration	OAR	Stabeno
Bhatt	**Uma**	Task I Request for S22378 - Quinn	49	$2,043	Administration	NMFS	DeMaster
Bhatt	**Uma**	Task I Request for S22396 - Cross	51	$11,342	Administration	OAR	Cross
Bhatt	**Uma**	Task 1 Request for S22176R - Cherry	53	$684	Administration	NESDIS	Goldberg
Bhatt	**Uma**	Task 1 Request for S22533 - Mueter	56	$1,397	Administration	NMFS	Mundy
Bhatt	**Uma**	Task 1 Request for S19631 - Cherry (multi year)	47	$18,494	Administration	NESDIS	Goldberg
Bhatt	**Uma**	Task 1 Request for S20088 - Iken (multi year)	52	$7,594	Administration	NOS/IOOS	Canonico
Bhatt	**Uma**	Task 1 Request for S22580 - Bhatt (Year 2)	54	$4,450	Administration	OAR	Cross
Bhatt	**Uma**	Task 1 Request for S22587 - Gibson	57	$1,672	Administration	NMFS	Aydin
Bhatt	**Uma**	Task 1 Request for S22544 - Kruse	58	$12,123	Administration	NMFS	Moss
Bhatt	**Uma**	Task 1 Request for S22563- West	61	$21,360	Administration	NWS	Angove
Bhatt	**Uma**	Task 1 Request for S22687 - Pinchuk	60	$2,425	Administration	NMFS	Cieciel
Bhatt	**Uma**	Task 1 Request for S22868R1 - Hopcroft	59	$2,451	Administration	OAR	Starkweather
Bhatt	**Uma**	Task 1 Request for S23460-Heinrichs	62	$29,378	Administration	NESDIS	Goldberg
Iken	**Katrin**	Arctic Marine Biodiversity Observing Network (AMBON) Graduate Student Traineeships (year 3 of 4)	52	$85,322	Education & Outreach	NOS/IOOS	Canonico

NOAA Non-Competitive Projects (NA13OAR4320056)							
Cherry	**Jessica**	High latitude proving ground for GOES-R: Advanced data products and applications for Alaska (year 3 of 3)	48	$207,798	Climate Change & Variability; Coastal Hazards	NESDIS	Goodman
Heinrichs	**Thomas**	HL Proving Ground - Improving forecast and warnings to deliver and test NPP/ JPSS data in support of operational forecasters-Supplemental	50	$225,000	Climate Change & Variability, Coastal Hazards	NESDIS	Goldberg
Cross	**Jessica**	Synthesis of Arctic Research (SOAR): CO2 Fluxes and Ocean Acidification in a Rapidly Changing Arctic	55	$40,000	Ecosystem Studies & Forecasting	OAR	Stabeno
Quinn	**Terrance**	Literature review of cetacean ship strikes & suggested mitigation meaures for use in Glacier Bay National Park - Year 2	49	$22,957	Ecosystem Studies & Forecasting	NMFS	DeMaster
Cross	**Jessica**	AFSC FY2015-FY2017 Alaska Ocean Acidification Research: Autonomous Observations of Ocean Acidification in Alaska	51	$127,440	Ecosystem Studies & Forecasting / Climate Change and Variability	OAR	Cross
Cherry	**Jessica**	River Ice and Flooding Iniative - Visit to Alaska During Breakup	53	$7,693	Climate Change and Variability	NESDIS	Goldberg
Mueter	**Franz**	Fish and fisheries in Central Arctic Ocean	56	$15,704	Climate Change and Variability	NMFS	Mundy
Bhatt	**Uma**	Innovative Technology for Arctic Exploration (ITAE) - Year 2	54	$50,003	Ecosystem Studies & Forecasting	OAR	Cross
Gibson	**Georgina**	Bering Sea NPZ model development and collaboration	57	$18,782	Ecosystem Studies & Forecasting	NMFS	Aydin
Kruse	**Gordon**	Gulf of Alaska Integrated Ecosystem Assessment Postdoctoral Research	58	$136,222	Climate Change and Variability	NMFS	Moss
West	**Michael**	Alaska Earthquake Center (AEC) Seismic Station Operations and Maintenance (CRESTnet)-Supplemental	61	$240,000	Coastal Hazards	NWS	Angove
Pinchuk	**Alexei**	Feeding habits of juvenile salmon, forage fish and scyphozoan jellyfish	60	$27,247	Ecosystem Studies & Forecasting	NMFS	Cieciel
Hopcroft	**Russell**	Request for support US participation in CBMP Expert Networks-Supplemental	59	$27,544	Ecosystem Studies & Forecasting	OAR	Starkweather
Heinrichs	**Thomas**	High Latitude Proving Ground - Improving forecast and warnings to deliver and test NPP/ JPSS data in support of operational forecasters-Supplemental	62	$345,622	Climate Change & Variability, Coastal Hazards	NESDIS	Goldberg
		Total projects funded (including CI administration)		**$1,726,156**			
		Task I - Recovery		$148,822			
		Task I - Project Awards		$85,322			
		Task II & III awards		$1,492,012			

APPENDIX 2 PERSONNEL

Appendix 2. Summary of CIFAR-funded personnel and their terminal degree (or degree seeking for students)

Category	Number	Unknown or none	B.A./B.S.	M.A./M.S. or M.B.A.	Ph.D.
Research Scientist	16			1	15
Visiting Scientist	0				
Postdoctoral Fellow	2				2
Research Support Staff	29	10	11	5	3
Administrative	3		1		2
Total (≥50 % NOAA Support)	0				
Total	**50**	**10**	**12**	**6**	**22**
Employees (≥50 % NOAA Support					
Located in NOAA Lab					
Obtained NOAA employment within last year					1
Undergraduate students			1		
Graduate students			1	8	11
Total students			**2**	**8**	**11**

APPENDIX 3 PUBLICATIONS

Summary table of publications during the current cooperative agreement NA13OAR4320056

	Institute Lead Author				**NOAA Lead Author**				**Other Lead Author**			
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 1	Yr 2	Yr 3	Yr 4	Yr 1	Yr 2	Yr 3	Yr 4
Peer-reviewed	0	1	1	1	0	0	2	1	0	1	12	4
Non Peer-reviewed	0	0	1	0	0	0	0	0	0	0	4	0
Accepted for publication	0	1	1	0	0	0	0	1	0	1	1	0

"Accepted" publications are peer-reviewed.

Year 1 = 1 July 2013-31 March 2014; Year 2 = 1 April 2014-31 March 2015; Year 3 = 1 April 2015-31 March 2016 Year 4 = 1 April 2016 – 31 March 2017

Peer-reviewed papers published, in press, or accepted for publication during the reporting period

CAFF. 2017. State of the Arctic Marine Biodiversity Report. Conservation of Arctic Flora and Fauna, Akureyri Iceland.

Cross, JN, Mathis, JT, Pickart, RS, and Bates, NR, 2017. Formation and transport of corrosive water in the Pacific Arctic Region. Deep-Sea Research II, accepted.

Gleason, C.M., B.L. Norcross, K.J. Spaleta. 2016. Otolith chemistry discriminates water mass occupancy of Arctic fishes in the Chukchi Sea. Marine and Freshwater Research 67: 967–979, http://dx.doi.org/10.1071/MF15084.

Mathis, J.T., and Cross, J.N., 2016. 'Ocean Acidification.' In: Richter-Menge, J., Overland, J.E., and Mathis, J.T., Eds. Arctic Report Card 2016, http://www.arctic.noaa.gov/Report-Card.

Mundy, P. R., Sunnanå, K., Ingvaldsen, R., Marsh, J., Jarvis, T., Astthorsson, T., Hoel, A.H. (2017) *Synthesis of Knowledge on Fisheries Science in the Central Arctic* Fourth Meeting of Scientific Experts on Fish Stocks in the Central Arctic Ocean (4th FiSCAO), Tromso, Norway, September 26 - 28, 2016.

Yun, M.S., T.E. Whitledge, D. Stockwell, S.H. Son, J.H. Lee, J.W. Park, D.B. Lee, J. Park and S.H. Lee. 2016. Primary production in the Chukchi Sea with potential effects of freshwater content. Biogeosciences 13:737-749.

Wolken, J.M., Lee, O., and Ibarguchi, G. 2016. The 2016 Arctic Observing Summit – the process and path forward. Northern Notes, 45:16-17.

APPENDIX 4 INDEX OF LEAD PRINCIPAL INVESTIGATORS

Cherry, J. 79

Cross, J. (Ocean acidification) 20

(SOAR) 23

(Autonomous) 26

(Technology) 34

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(GOES-R) 72

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Gibson, G 56

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(RUSALCA data management) 37

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APPENDIX 5 LINKED PROPOSALS

Appendix: Reporting on CIFAR Linked Proposals

1 April 2016 - 31 March 2017

During this reporting period, CIFAR oversaw five linked proposals, as summarized in the table below. Two of these projects, NA16NWS4680006 and UCAR Subaward Z16-23490, submitted reports to their respective project managers during this time period. These two reports are included in this appendix. No such reporting was required from the other three projects during this time period.

PI	Project Title	Project
Bhatt, Uma	Seasonal Climate Forecasting Applied to Wildland Fire Management in Alaska	NA16OAR4310142
Heinrichs, Thomas	Adaptive, High Resolution Modeling for the Arctic Test Bed at NWS Alaska	NA16NWS4680006
Cherry, Jessica	Aerial monitoring of flood inundation and river ice breakup process	SUABWARD Z16-23490
Hopcroft, Russell	Long-term observations of Pacific-Arctic Zooplankton communities	NA16OAR4310246
Lovecraft, Amy	Arctic Sustainability Research in support of the Arctic Policy and Governance Educational Partnership	PO WE-133F-16-SE-1598

University: University of Alaska Fairbanks

Name of University Researcher Preparing Report: Jessica Cherry

NWS Office: Alaska Pacific River Forecast Center and National Operational Hydrologic Remote Sensing Center

Name of NWS Researcher Preparing Report: Crane Johnson

Type of Project (Partners or Cooperative): Partners

Project Title: Aerial monitoring of flood inundation and river ice breakup processes

UCAR Award No.: UCAR Subaward Z16-23490

Date: 16 March, 2017

Section 1: Summary of Project Objectives

The core objectives of the project were to capture ortho-imagery of river breakup and snow melt processes in Interior Alaska. The river breakup imagery is a quantitative mapping improvement to qualitative observations by participants in the Alaska State River Watch program. The snowmelt processes imagery was comparable to the measurements taken by NOAA National Operational Hydrologic Remote Sensing (NOHRSC) via an independent method.

Section 2: Project Accomplishments and Findings

This project was a highly successful collaboration between the University of Alaska Fairbanks (UAF), the National Water Center/NOHRSC, the Alaska Pacific River Forecast Center (APRFC), the Fairbanks Weather Forecasting Office, the NESDIS Joint Polar Satellite System (JPSS) Proving Ground Program, and the NOAA Hollings Scholar Program. Flights were conducted and data analyzed pertaining to snowmelt processes, river breakup, and potential flood inundation. Results were presented in a talk at the Eastern Snow Conference in Columbus Ohio in June, 2016, in a seminar at the University of Alaska Fairbanks' Institute of Northern Engineering (September, 2016), and to the general public at the Experimental Aviation Association's monthly meeting (July, 2016). Breakup imagery was published in the local Fairbanks and Anchorage newspapers and the team was interviewed on several local TV and radio stations. After the culmination of the project, the PI, Cherry, left her faculty position at UAF and joined the APRFC as a staff member bringing her knowledge to operations at NOAA.

Figure 1: Some members of the project team with the aircraft: Sanmei Li (GMU, JPSS Proving Ground collaborator), PI Jessica Cherry (UAF), Craig Kenmonth (contract pilot)

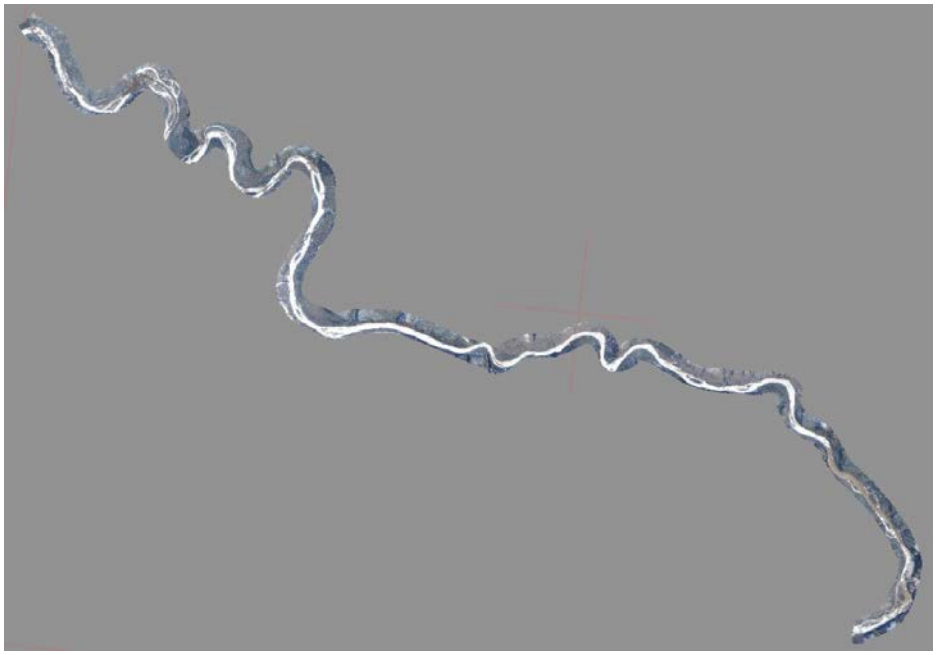


Figure 2: The orthomosaic of the Upper Yukon from Dawson City to Circle on April 21, 2016.

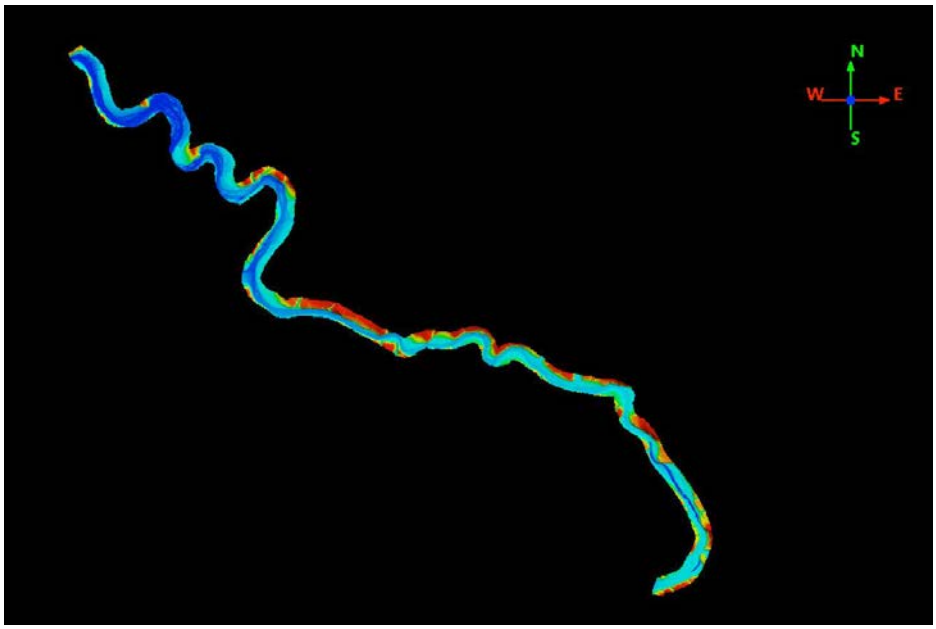


Figure 3: The digital surface model of the Upper Yukon from Dawson City to Circle City on April 21, 2016.

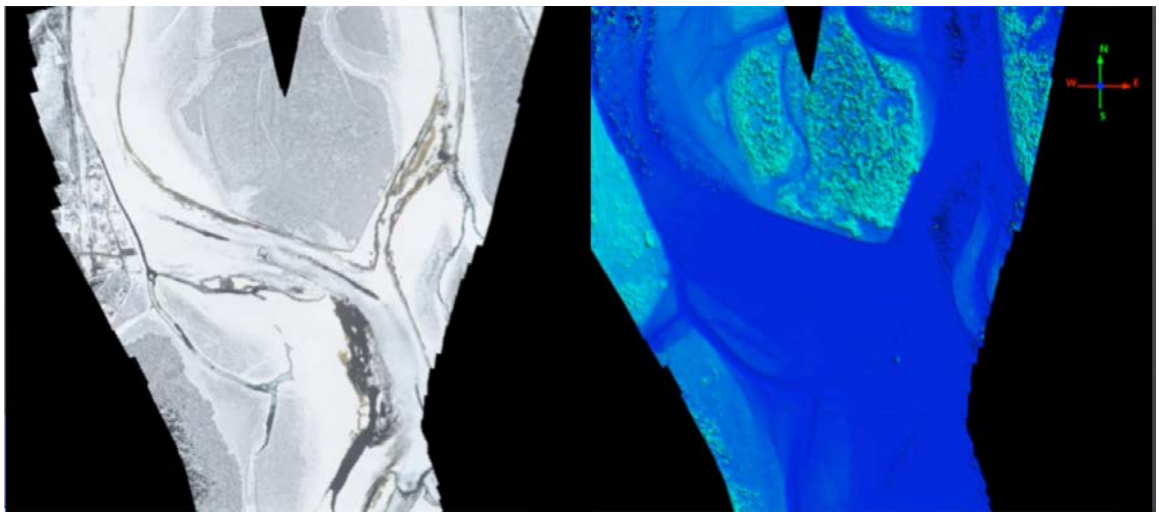


Figure 4: A closeup of the orthomosaic (left) and the digital surface model (right) near Circle City on April 21, 2016.

Figure 4: Post-breakup orthomosaic of Eagle collected for use in inundation model.

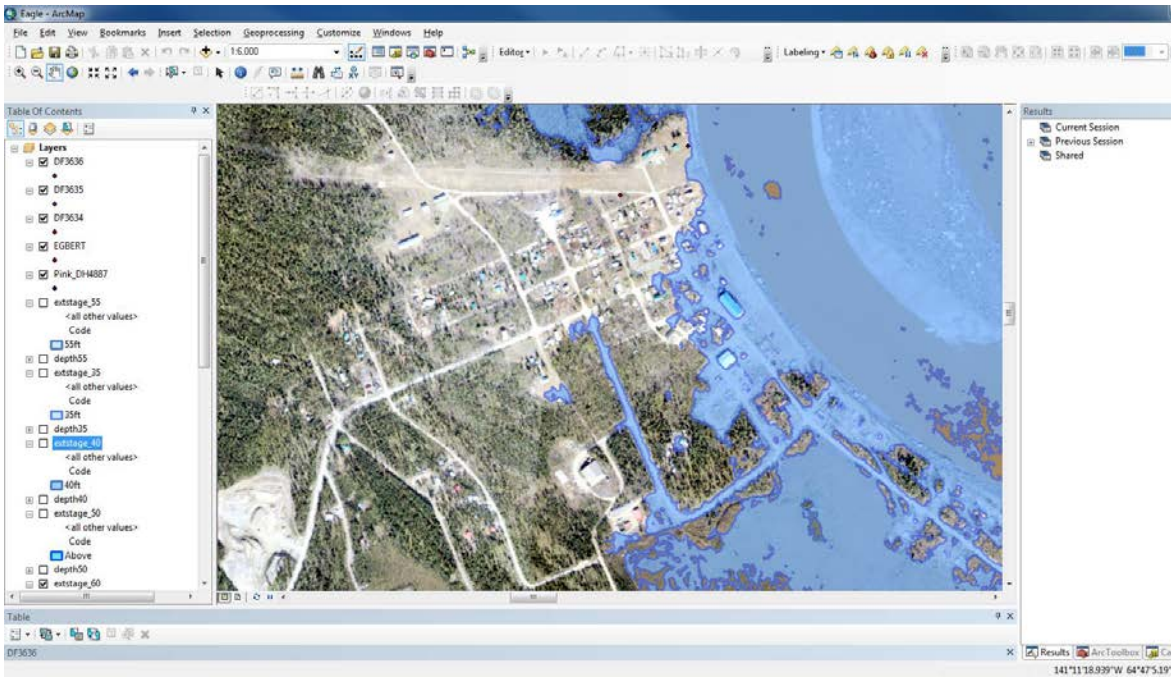


Figure 5: Bathtub model of inundation in Eagle with stage level at 60 ft overlaid on Eagle orthomosaic. Results from summer Hollings Scholar Haley Canham working with Cherry and Fairbanks WFO Service Hydrologist Ed Plumb.

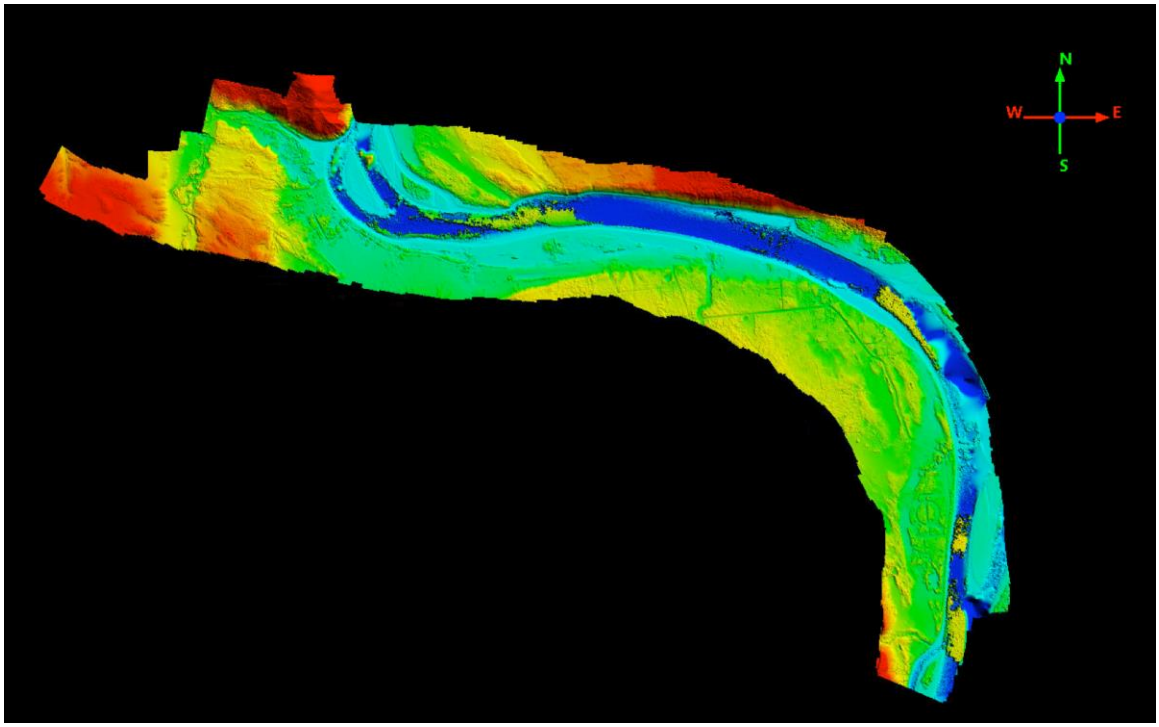


Figure 6: The digital surface model of Eagle derived from the orthoimagery.

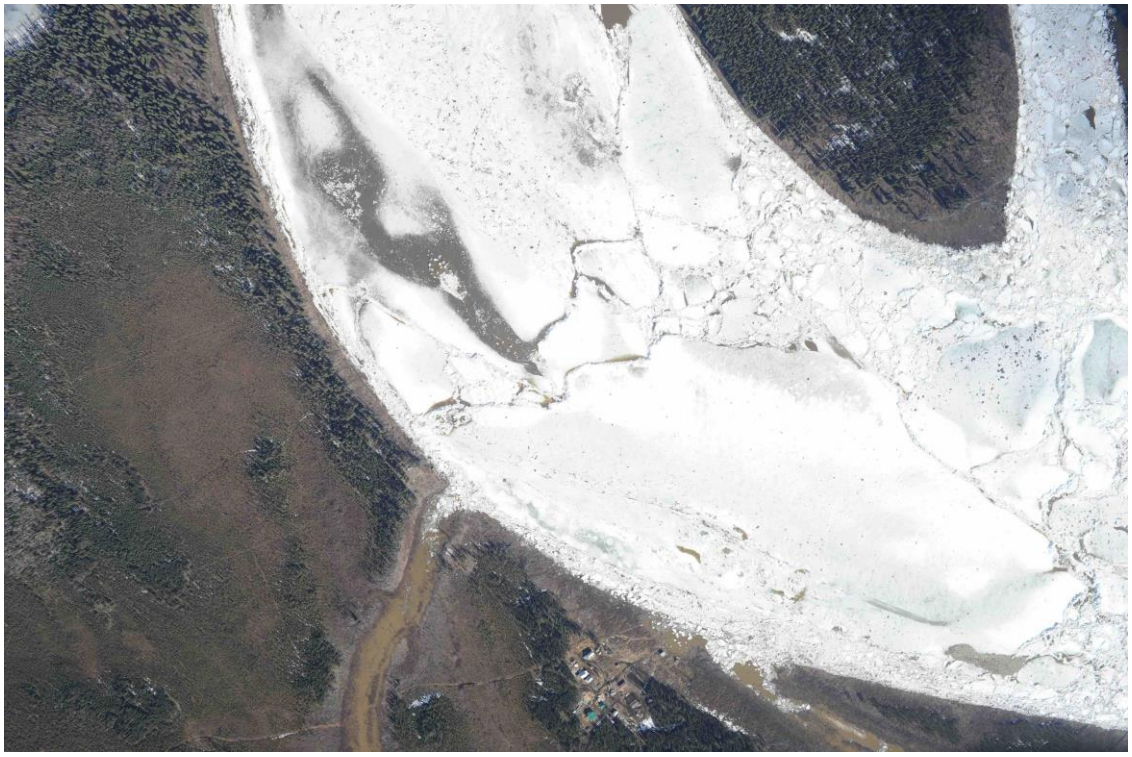


Figure 7: A close up of an ice jam near Eagle at Calico Bluff taken by Cherry during the 2016 flights. The homestead with water encroaching can be seen at the bottom of the image. A story with this ice jam image was published in the Fairbanks and Anchorage newspapers.

Figure 8: A view of the ice jam from the homesteader.

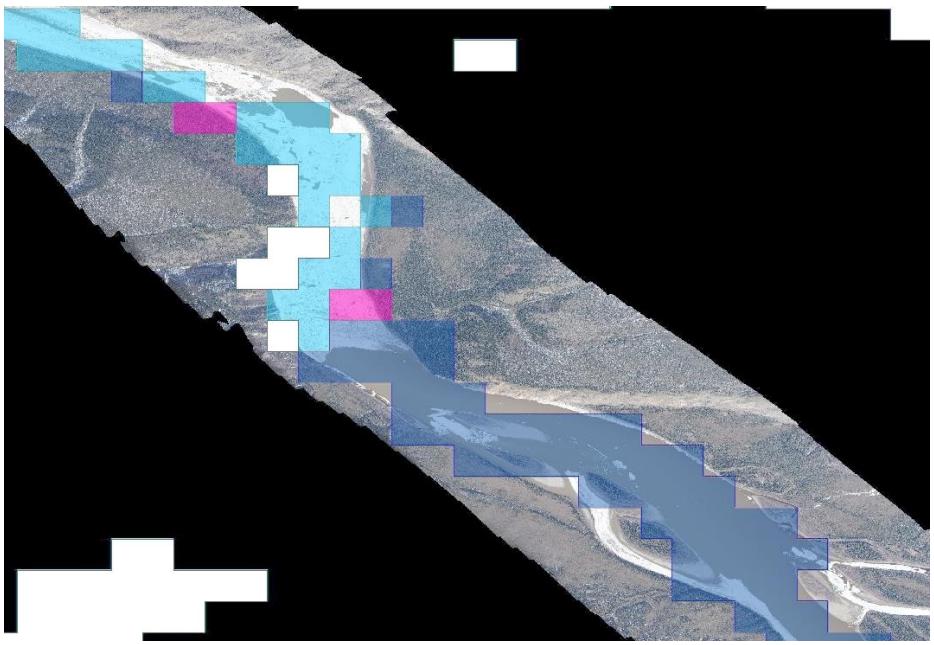


Figure 9: A comparison with the JPSS Proving ground satellite based river ice product and Yukon river aerial imagery.

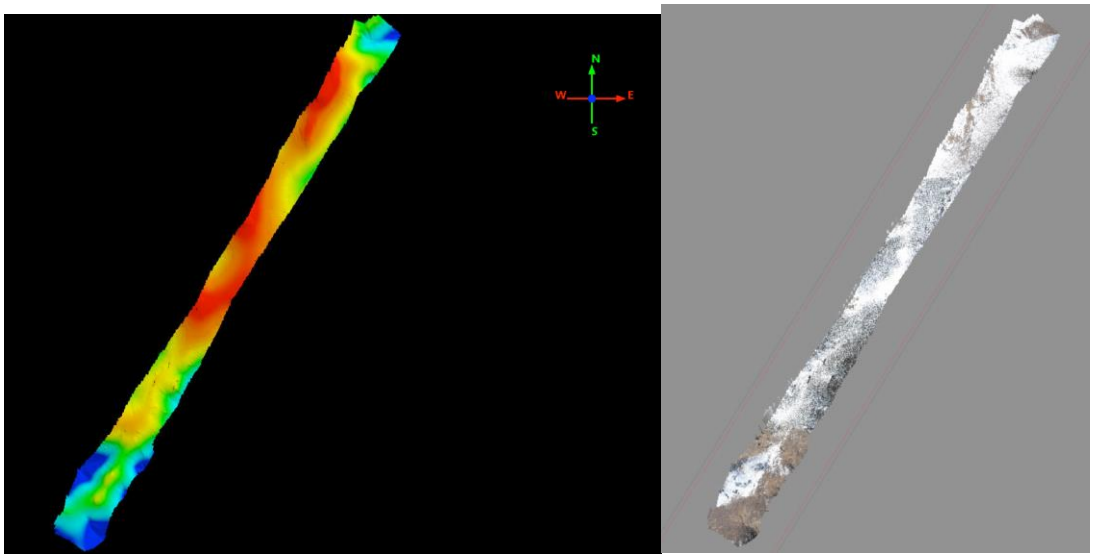


Figure 10: One digital surface model and orthomosaic time slice from time series of snow depletion at

NOHRSC flight line site. Surface model height changes are are being compared to gamma detection values collected by NOHRSC.

Section 3: Benefits and Lessons Learned: Operational Partner Perspective
The APRFC had the opportunity to incorporate near real time ortho-imagery into their situational awareness and forecast process. The unit also got to know Cherry better and ultimately brought her onboard the NWS where she is now helping include remote sensing data into the APRFC operations.

Section 4: Benefits and Lessons Learned: University Partner Perspective
This project benefited the university by showing that remote sensing research could be pulled into NWS operations. Cherry also had the opportunity to interact with an undergraduate NWS Holling scholar

Section 5: Publications and Presentations

Cherry, J.E., 2016: Recent Airborne Remote Sensing of Snow, Ice and water in Alaska. *Eastern Snow Conference 2016,* Columbus, OH (Oral Presentation).

Cherry, J.E., 2016: Recent Airborne Remote Sensing of Snow, Ice and water in Alaska. *University of Alaska Fairbanks Water and Environment Research Center Seminar,* Fairbanks, AK (Oral Presentation).

Cherry, J.E., 2016: Airborne Science in Alaska. *Interior Alaska Chapter Experimental Aircraft Association,* North Pole, AK (Oral Presentation).

Section 6: Summary of University/Operational Partner Interactions and Role

Cherry (UAF) planned and executed the flights with input from Johnson (NWS) and Olheiser (NOAA) and the NOHRSC pilots. Data were collected, processed, and then transmitted to the NWS/APRFC. Initial results were presented to NWS personnel and formally to the research community and general public. Interpretation and further analysis is ongoing.

CSTAR Progress Report

Adaptive, High Resolution Modeling for the Arctic Test Bed at NWS Alaska

Reporting Period: 01 May 2016 - 31 October 2016

Grant number: NA16NWS4680006

PI: Tom Heinrichs (University of Alaska Fairbanks)
Co-I's: Don Morton (Boreal Scientific Computing, LLC);
Jiang Zhu and Jessica Cherry (UAF)

Primary report writer: Don Morton
Submitted: 17 November 2016

Overview

This project is supporting implementation and evaluation of a weather model: the High Resolution Rapid Refresh (HRRR) for Alaska. The current project tasks and milestones evolved in the period between the proposal submission and the start of work. However, the overall goal remains the same; following on the success of the HRRR in the continental US, our goal is to provide a HRRR forecast to the NWS in Alaska and evaluate its skill though web based tools.

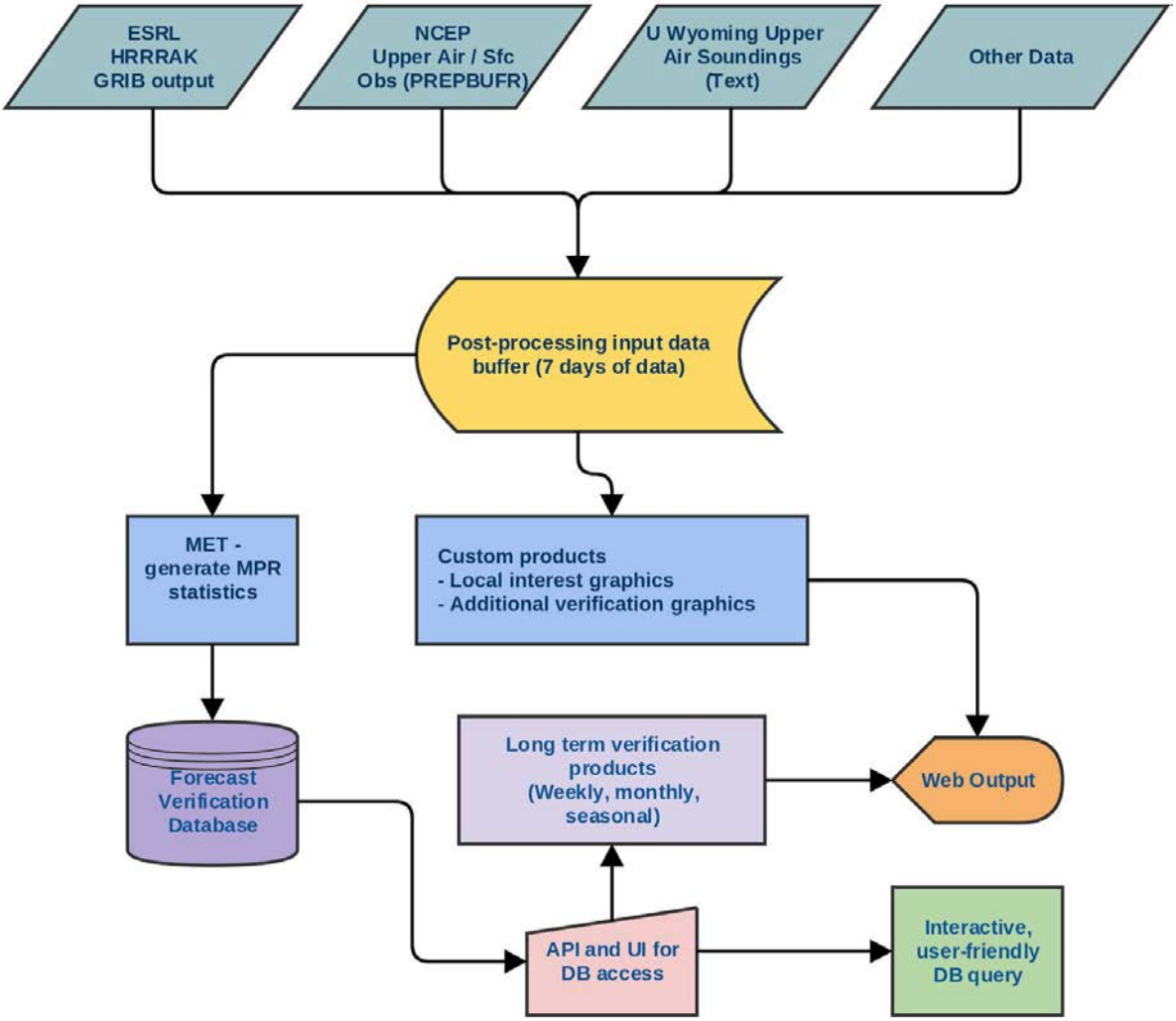
At the time of proposal submission there was no real-time high-resolution forecast for the Alaska Region, and our primary goal was to deploy a version of the High Resolution Rapid Refresh (HRRR) for Alaska - the HRRRAK. We had initiated a similar project in the past and had enjoyed productive collaborations with the NOAA/ESRL/GSD HRRR group. This effort was internally funded and ended in April 2015 due to cuts to the University's budget.

In early 2016, given the uncertainties in UAF budgets, the ESRL HRRR group decided to start running their own HRRRAK operationally, so that by the time our group was notified of funding, ESRL had HRRRAK running on NOAA resources. Because we all have the same long-term goal -- to deploy a high-quality, high-resolution, operational weather model for Alaska -- UAF, ESRL, and NWS Alaska Region jointly developed a suite of tasks to complement and enhance the HRRRAK runs being made in Boulder.

It was agreed that it would be productive for our CSTAR-funded group at UAF to help assess performance of the forecasts and to perform several case studies to experiment with assimilation approaches that the ESRL HRRR group did not have sufficient staff time to perform. Additionally, the agreed upon, shared goal remained the same as originally proposed: to ultimately bring the experimental HRRRAK to a level where it could migrate to NCEP to be fully operationalized as a member of the suite of national forecast models.

Project activities started in June 2016, and the primary emphases during this reporting period have been

- Through extensive coordination with NOAA/ESRL/GSD and Alaska Region NWS, we developed an initial approach and plan for activities in support of the NWS.
- A shared project reporting environment (wiki) for CSTAR project members, NOAA collaborators, and CSTAR porgram managers was established at https://sites.google.com/a/borealscicomp.com/hrrrak. Much of the site is intended for "internal use" and is not available to the public.
- We evaluated and modified our approach to computing resources. The initial proposal assumed that we would be performing regular, quasi-operational runs on UAF-owned high performance computing equipment. Because the routine, quasi-operational runs are now being performed by ESRL in Boulder on NOAA resources, the UAF focus shifted to the assimilation and evaluation aspects and design of case studies. Given this, UAF has chosen to run on more portable options, via virtualization and containerization, that allow us to move customized computing environments between cloud resources (e.g. Amazon Web Services, RackSpace, etc.) and local computing environments.
- Preparation of computing resources is currently underway to
    - Construct a cloud-based operational HRRRAK verification system. This system assesses HRRRAK forecasts against observations using a database we have developed. It facilitates novel queries to determine the strengths and weaknesses of the HRRRAK performance. After accumulating sufficient input, this will be useful in discovering and then focusing our energies on rectifying some of HRRRAK's weaknesses.



- Construct a Virtual Machine environment that will allow us to run HRRRAK case studies (this will include GSI, WRF, and postprocessing) in cloud and local environments

- Coordination and planning is underway for a first case study of the HRRRAK, focused on ceiling and visibility (C&V) events over in Alaska. ESRL/GSD and Alaska Region NWS are supporting this activity. We have established a target of mid-December 2016 to accomplish this first case study. In addition to investigation of valuable HRRRAK performance metrics, we see this as a great opportunity to assess our own workflow for future project activities.
- We coordinated with NOAA to support Jiang Zhu's submission of proposal for complementary activities to be performed as a visiting scientist with NCAR's

Developmental Testbed Center (DTC). This supplemental activity (funded by DTC) will increase Dr Zhu's already extensive knowledge of WRF and enable him to meet and work alongside NOAA and UCAR modellers in Boulder. We proposed to conduct Hybrid 3Dvar and ENKF data assimilation on a clone HRRRAK model. The NUCAPS profiles and polar wind will be used as input of the assimilation scheme, respectively. We evaluate the performance of a model output by calculating the RMSE between the WRF output and "ground truth" data. MET tools are used to pair the matched data in model output and ground truth data. Conventional observation data and GDAS analysis data will be used as "ground truth" data.

CSTAR Progress Reporting Items

1. ***Key scientific accomplishments***

   No significant scientific accomplishments, yet. Discussions have been held to plan activities. These will lead to results informing the evolution of the HRRRAK.

2. ***Any issues delaying current or future progress***

   The start up of significant project activities was delayed for approximately two months in order to a) coordinate budget category changes with program manager related to investigator roles and b) meet with Alaska Region NWS and NOAA ESRL/GSD personnel to develop modified plans. In light of NOAA's launch of an experimental, quasi-operational HRRRAK, we need to modify plans in order to maintain the original project goal of working together to evaluate and enhance the HRRRAK for Alaska conditions that can ultimately lead to it migration to the NCEP operational suite.

   As described above, a change has been our planned use of computational resources. In the original proposal, we planned to purchase additional compute nodes that would be used full-time for experimental HRRRAK runs. Because NOAA ESRL/GSD is committed to performing the quasi-operational runs (at a much higher level than UAF would have been able to), we have chosen not to purchase computer equipment. With our revised emphasis on the performance of post event case study simulations, we have been investigating and preparing for use of the Amazon Cloud and investigating other complementary possibilities. Also, Amazon Cloud resources will be used for the HRRR-AK verification system described above. Project personnel have applied for accounts on NOAA's *theia* and *jet* (where HRRRAK currently runs) and are pursuing access to NCAR's *yellowstone* and *cheyenne* (where HRRR can run) as part of the Developmental Testbed Center visitors program. These changes have led to a higher initial emphasis on arranging our computational infrastructure, but we are still on-target to start using and assessing it in the form of a case-study and verification services by end of 2016 calendar year.

3. *Interactions with NOAA scientists at WFO's, NCEP Centers, Regional Offices, etc.*

A number of formal and informal meetings have been conducted among UAF project personnel, NOAA ESRL/GSD HRRRAK, ESSD and WFO's in the Alaska Region. In addition to teleconferences, email, and the project wiki, UAF personnel have visited the Alaska Region in Anchorage, and NOAA ESRL/GSD sent their HRRRAK lead (Trevor Alcott) to Fairbanks for two days of meetings and joint work sessions.

We have been interacting with Alaska Region WFO forecasters and NOAA ESRL/GSD to devise a forecaster reporting system that will help us understand how HRRRAK is being used and what forecasters like and don't like about the model.

We have submitted a proposal to the Development Test Center for Jiang Zhu to spend time in Boulder as visiting scientist to work with NCAR and NOAA modelers. The proposal required several iterations with DTC and our ESRL collaborators but resulted in a plan to maximize the efficacy of Dr Zhu's visits to Boulder.

4. *Progress against milestones/schedules in proposal*

Original and modified milestones are presented at the bottom of https://sites.google.com/a/borealscicomp.com/hrrrak/home/shared-spaces/project-planning-documents/summer-2016-initial-planning

Year 1 tasks and outcomes -- status summary

- [in progress; 85% complete] Scoping, understanding visions and directions of the CSTAR / ARH / NOAA team
- [in progress; 50% complete] Decide on and deploy and test any of the computational resources we are going to be using
- [in progress; 30% complete] Initial deployment of model verification structure
- [pending; 0% complete] Development of additional post-products from the HRRRAK, of interest to Alaska entities
- [in progress; 40% complete] Development of a workflow for performing case studies - in particular, data acquisition and storage
- [pending; 0% complete] Pre-processing workflow for any potential data to be test-assimilated
- [in progress; 10% complete] Performance of an initial "shakedown" case study to understand current strengths and weaknesses for execution of future case studies

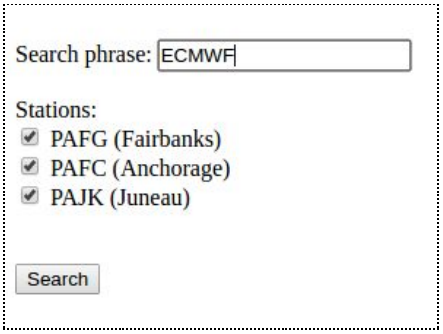
5. ***Any previously unreported changes to the execution of the originally submitted proposal***

   Described above in Overview and previous items.

6. ***Any outcomes that could be transitioned or offered to operations (previous outcomes can be repeated)***

   As part of determining how forecasters use the HRRRAK, we have deployed a web service that allows users to search through web-posted Area Forecast Discussions for specified phrases. Our immediate interest is in searching for words like HRRRAK, but the service has been designed with a broader scope in mind. This is currently running as a provisioned application in the Amazon Cloud, and serves as an important prototype for some of the other services that we plan to deploy for this project.

   Beta version screenshots



Report of AFD Scan for search string: *ECMWF*

Another search...

WFO: PAFC

428 PM AKST Sun Nov 13 2016 --- Number of matching lines: 0

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428 PM AKST Sun Nov 13 2016 --- Number of matching lines: 0

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435 PM AKST Sat Nov 12 2016 --- Number of matching lines: 0

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423 AM AKST Sun Nov 13 2016 --- Number of matching lines: 0

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435 PM AKST Sat Nov 12 2016 --- Number of matching lines: 0

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425 AM AKST Fri Nov 11 2016 --- Number of matching lines: 1

the eastern domain and ECMWF/GFS for the west.

WFO: PAFG

238 PM AKST Sun Nov 13 2016 --- Number of matching lines: 0

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7. *Critical budget issues (separate financial forms are required)*

No budget problems. Spending is slightly behind pace due to our slow start; it is getting on track. A rebudget was performed to move Don Morton's time from UAF salary and benefits to contractual services because he left UAF employment and is working for the project as an independent contractor through his company, Boreal Scientific Computing, LLC. A second rebudget will be requested in the coming months after the computing approach is finalized. As described in item 2, we are approaching this differently and will very likely move the computing equipment budget line item into contractual services to be spent with cloud computing providers.

Appendix A

Below is the original abstract followed by its modification. The primary changes simply reflect our new role of working closely with NOAA ESRL/GSD in support of the HRRRAK runs they are performing and to ultimately prepare the HRRRAK for NCEP operational runs.

Original abstract

We propose to deploy a near-real time, adaptive, state-of-the-art atmospheric model for improved forecasting of weather in Alaska, including high impact events. The model--High Resolution Rapid Refresh (HRRR)--is running routinely in the continental United States (CONUS) but is not currently run by NOAA for the Alaska domain. The effort (HRRR for Alaska or HRRRAK) will first establish model configurations and data input/outputs at the University of Alaska's Geographic Information Network of Alaska (GINA), in consultation with NOAA's Earth System Research Lab (ESRL), then work to transition this to operations at ESRL, on a pathway to the National Center for Environmental Prediction (NCEP). The team will work directly with the National Weather Service's (NWS) Regional Weather Forecast Offices, the Alaska Aviation Weather Unit, the Alaska Pacific River Forecast Center, the Sea Ice Program, and the new Arctic Test Bed to develop, test, evaluate, and train forecasters on the forecast products. The team will build on members' experiences deploying an experimental HRRRAK forecast twice a day at the Arctic Region Supercomputing Center, as well as team members' roles as lead of the High Latitude Proving Ground for generation of remote sensing products for the National Weather Service (NWS). While the forecast will be available on operational time scales, the evaluation period and forecaster feedback will also focus on three case studies related to hazardous weather in the Arctic Test Bed region: 1) a scenario involving ocean-going vessels needing to navigate moving sea ice; 2) a scenario involving coastal or mountain aviation hazards; and 3) a scenario during river ice breakup when many communities in Alaska are vulnerable to ice jam flooding following a sudden warm up. After initial development at GINA, and evaluation in Alaska's NWS offices, these experimental HRRRAK runs will be transitioned to ESRL during the course of the project and a plan will be devised for permanent, operational runs at NCEP. As part of the model system development and evaluation, data assimilation into HRRRAK using satellite data directly captured in Alaska will be implemented and a suite of validation analysis and visualization tools deployed. Team members also propose to train forecasters on the model analysis and visualization via two NWS liaisons housed at GINA.

Revised (new) abstract

We will enhance the operation and outreach of the real-time, adaptive, state-of-the-art numerical weather prediction model - High Resolution Rapid Refresh for Alaska (HRRRAK) - currently deployed on an experimental basis at NOAA's Earth System Research Lab (ESRL). The long-term goal is to work with NOAA ESRL and the National Weather Service (NWS) in Alaska to improve the model and demonstrate its value in real-world cases of importance to the diverse communities in Alaska, working to transition real-time operations to the National Center for Environmental Prediction (NCEP). The effort will first investigate and establish model configurations and data input/outputs at the University of Alaska's Geographic Information Network of Alaska (GINA). The team will work directly with the National Weather Service's (NWS) Regional Weather Forecast Offices, the Alaska Aviation Weather Unit, the Alaska Pacific River Forecast Center, the Sea Ice Program, and the new Arctic Test Bed to develop, test, evaluate, and train forecasters on the forecast products. The team will build on members' experiences with an experimental HRRRAK forecast at the Arctic Region Supercomputing Center from 2010-2015, as well as team members' roles as lead of the High Latitude Proving Ground for generation of remote sensing products for the National Weather Service (NWS). While the forecast is available on operational time scales, complementary activities will focus on a number of case studies related to hazardous weather in the Arctic Test Bed region such as 1) a scenario involving ocean-going vessels needing to navigate moving sea ice; 2) a scenario involving coastal or mountain aviation hazards; and 3) a scenario during river ice breakup when many communities in Alaska are vulnerable to ice jam flooding following a sudden warm up. Additional case studies will be considered as a result of consultation with Alaska weather interests and careful analysis of current HRRRAK performance. Over the course of the project a plan will be devised for permanent, operational runs at NCEP. As part of the model system development and evaluation, data assimilation into HRRRAK using satellite data directly captured in Alaska will be investigated and a suite of validation analysis and visualization tools deployed. Team members also propose to train forecasters on the model analysis and visualization via two NWS liaisons housed at GINA.