

First progress report to NOAA on Cooperative Agreement NA130AR4320056

1 July 2013 – 31 March 2014





First report from CIFAR to NOAA on Cooperative Agreement *NA13OAR4320056*

1 July 2013-31 March 2014

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Cover photo is from the 2009 RUSALCA cruise, taken by Aleksey Ostrovskiy. Report layout and production by Barb Hameister, CIFAR.

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 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.

Research Themes for CIFAR

- 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.
- 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 CIFAR Executive Board members are:

Christopher Sabine, NOAA Office of Oceanic & Atmospheric Research (OAR) Pacific Marine Environmental Laboratory (PMEL) Director

Kathy Crane, NOAA OAR Arctic Research Office Program Manager (effective 12/3/2013)

Douglas DeMaster, NOAA National Marine Fisheries Service (NMFS), Director, Alaska Fisheries Science Center (AFSC)

Philip Hoffman, NOAA OAR Cooperative Institutes (CI) Program Office Director

Mark Myers, University of Alaska Fairbanks (UAF), Vice Chancellor for Research

James Partain, NOAA, National Weather Service (NWS) Regional Climate Director for Alaska

John Walsh, CIFAR director, ex officio (retired)

Susan Sugai, CIFAR director, ex officio (effective 7/1/2013)

The CIFAR Fellows are:

- 1. Larry Hinzman, Director, International Arctic Research Center (IARC), UAF, Fairbanks, AK
- 2. Kris Holderied, National Ocean Service, NOAA, Homer, AK
- 3. Anne Hollowed, AFSC, NMFS, NOAA, Seattle, WA
- 4. Henry Huntington, Huntington Consulting, Eagle River, AK
- 5. Zygmunt Kowalik, Professor Emeritus of Physical Oceanography, Institute of Marine Science (IMS), School of Fisheries and Ocean Sciences (SFOS), UAF, Fairbanks, AK
- 6. Gordon Kruse, President's Professor of Fisheries, SFOS, UAF, Juneau, AK
- 7. Molly McCammon, Director, Alaska Ocean Observing System, Anchorage, AK
- 8. Phil Mundy, Division Director, Auke Bay Laboratory, AFSC, NMFS, NOAA, Juneau, AK
- 9. James Overland, Oceanographer, PMEL, NOAA, Seattle, WA
- 10. Carven Scott, Chief, Environmental & Scientific Services Division, NWS, NOAA, Anchorage, AK
- 11. Denby Lloyd, Executive Director, North Pacific Research Board, Anchorage, AK
- 12. Terry Whitledge, IMS, SFOS, UAF, Fairbanks, AK
- 13. Katrin Iken, IMS, SFOS, UAF, Fairbanks, AK

Summary of Awards Made during Reporting Period

During the first 9 months of our renewal cooperative agreement NA13OAR4320056, NOAA provided 12 amendments to the CIFAR renewal agreement for CIFAR administration and 11 research, education, and outreach awards totaling \$1.47M. All 11 research awards were Task III (projects that generally require only minimal direct collaboration with NOAA scientists). A full list of CIFAR awards made during the reporting period is presented in Appendix 1. Amendment 12 totaling \$244,315 are funds deobligated from CIFAR's former shadow award NA08OAR4320870 that expired on 30 June 2013.

Summaries of CIFAR awards funded this reporting period by task/theme and funding source are presented in Tables 1 and 2, respectively. Figure 1 shows the distribution of CIFAR Task III research projects (percentage of total) by NOAA line office.

Table 1. Summary of CIFAR Awards Funded 1 July 2013–31 March 2014: By Task and Theme

Theme	Number of Awards	Total Amount	Subtotals by Task	Percent of Total
				(rounded)
Administration (Task I)	2		\$110,000	7.48%
Core Support	2	\$110,000		
Research Themes (Task II)	0		\$0	0.0%
Research Themes (Task III)	11		\$1,360,029	92.52%
Climate Change & Variability	1	\$112,500		7.65
Coastal Hazards	3	\$476,176		32.39
Ecosystem Studies & Forecasting	7	\$771,353		52.47
Total	13		\$1,470,029	100.0%

Table 2. Summary of CIFAR Awards Made 1 July 2013–31 March 2014: By Funding Source Includes administration

			Percent of
Funding Source	Number of Awards	Total Amount	Total
OAR	9	\$974,295	66.3%
NESDIS	2	\$272,023	18.5%
NWS	1	\$187,488	12.7%
NMFS	1	\$36,223	2.5%
Total	13	\$1,470,029	100.0%

CIFAR Funding by Line Office for Task III Awards Only (Year 1)



Figure 1. Percentage of total CIFAR Task III funding by line office for FY13.

Highlights of CIFAR Task I Activities

CIFAR is currently staffed by two people: Susan Sugai, director and acting CIFAR administrator; and Barb Hameister, publications and meetings manager. This situation is less-than-optimal for CIFAR, but given declining funds from both NOAA and UAF, recruiting a part-time fiscal manager to act as CIFAR administrator has proven difficult. However, it is hoped that Sarah Garcia, who served as CIFAR administrator from March 2010 to August 2011, can be soon hired to fill this role on a 62% full-time equivalent (FTE) basis. Sarah has assisted on a limited basis during this reporting year.

Core Administration

With tightening state appropriated funds and delay in implementing changes in CIFAR Task I support, we have experienced problems in recruiting new staff for CIFAR while planning for a leadership transition in 2016. For this reporting period CIFAR Task I funds (NA08OAR4320870) supported 609 hours of the CIFAR director, while University match funds (for year 1 of NA13OAR4320056) provided the remainder of core administrative labor costs. Because CIFAR has been without a CIFAR administrator for the current reporting year, Garcia has been assisting Sugai with these responsibilities on "as available" status (~4% FTE), and Sugai's efforts have increased to 58% effort during this transition between expiring shadow and core cooperative agreements and our renewal cooperative agreement.

- Susan Sugai, CIFAR director, 58% FTE (Task I + UA match funds)
- Sarah Garcia, temporary assistance, 4% FTE (Task I + UA match funds)
- Barb Hameister, publications and meetings manager, 22% FTE (Task I + UA match funds)

Susan Sugai, CIFAR director, provides overall CIFAR programmatic guidance, oversees daily operations and serves on the 25-member NOAA Alaska regional collaboration team. She is responsible for submitting all CIFAR proposals, setting up post-award budgets, and overseeing reporting obligations. In November 2013, Sugai worked with CIFAR PI Katrin Iken to submit a proposal for the NOAA-National Ocean Service-Integrated Ocean Observing System (IOOS) FY2014 Demonstration of a U.S. Marine Biodiversity Observation Network (Marine BON).

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 has placed specific emphasis upon 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 bring together faculty and students from various departments and campuses to collaborate with NOAA scientists on research and educational efforts.

Global Change Student Research Program (Graduate and Undergraduate Support)

Because of the low level of Task I funding provided by NOAA, CIFAR education efforts have focused on the Global Change Student Research Grant Competition, established by the UAF Center for Global Change in 1992. The competition provides support to students for research related to global change with a focus on arctic or boreal regions presented in an interdisciplinary context. The work may involve the social, biological, and physical sciences and engineering. This competition is designed to give students experience with proposal writing and the peer review system as practiced by science funding agencies. During the 2013 funding cycle, all CIFAR-funded students were supported with Task 1 support from NA08OAR4320751. Because NA13OAR4320056 was initially set up with minimal Task 1 support (\$10,000), the University match funds were not made available to us until well after the state fiscal year when we need to transfer funds for our Global Change Student Research awards.

In response to the 2014 announcement of funding opportunity, 26 proposals were received, reviewed, and considered by our review panel on 4 April 2014. Successful student awards will be made with both CIFAR task 1 funds and those from our UAF match.

Student Support through Individual Awards

As shown in Appendix 2, 2 graduate students were funded through CIFAR RUSALCA projects, and both received more than 50% of their support from NOAA. In addition, many other students benefited from involvement in the research projects, e.g., through sample/data collection and data analysis, even though they did not receive direct salary support through CIFAR.

Other CIFAR Administrative Activities

A joint teleconference meeting of the CIFAR Executive Board and Fellows was held 25 November 2013, where new funding opportunities and the current plan for CIFAR succession were discussed.

Highlights of CIFAR Research Activities

During the first 9 months of the renewal CIFAR cooperative agreement, 10 research projects were begun (deobligated funds from amendment 12 were folded into existing projects) and progress reports are provided. Some NA08OAR4320751 projects received new increments of funding under NA13OAR4320056 so the progress reports for these continuing projects are identical in the two reports. Projects in CIFAR's renewal cooperative agreement will be referred to by our NOAA CI acronym (CIFAR) and the most recent federal fiscal year of funding (in this report, 13) preceded by an R (for renewal) and then the amendment number of the most recent increment of funding. Thus, for example, our task 1 funding, which was received as amendments 0 and 5, would have the shorthand reference of CIFAR R13-05.

Two continuing awards are undergoing administrative changes from our previous cooperative agreement.

- In NA08OAR4320751, the Alaska Consolidated Reporting of Earthquakes and Tsunamis (Alaska CRESTnet) effort was initially funded as a task under the Tsunami Warning and Environmental Observatory for Alaska (TWEAK) umbrella of awards. Although TWEAK is not continuing in the CIFAR renewal agreement, CRESTnet (CIFAR R13-07) continues, but operations will be reevaluated based upon reduced funding available.
- 2. Research on the use of two small Unmanned Aerial Systems (UAS) to map marine debris from the 2011 Japanese tsunami (CIFAR R13-11) continues under the direction of Marty Rogers, PI. The change of PI request was submitted by UAF to NOAA in February 2014, and although it had been finalized for NA08OAR4320751, it had not been approved by NOAA for NA13OAR4320056 prior to submission of this report. Thus, progress reports reflect "official PI" at time of submission.

Ecosystem Studies and Forecasting

Four Russian-American Long-term Census of the Arctic (RUSALCA) projects are continuing under CIFAR's renewal agreement and all are in the data analysis, synthesis, and publication stage having collected samples on cruises in 2004, 2009, and 2012. Many of the publications in preparation will have students as senior or junior authors and should be submitted to peer-review journals in the next reporting period. Development of a RUSALCA data management system (CIFAR R13-10) will provide the data infrastructure for examining the potential impacts of climate change in the Pacific-Arctic gateway as well as place RUSALCA data into the public domain.

Publications and Presentations

At this early stage of the renewal cooperative agreement, there are no publications to report. Twelve conference presentations (both national and international) were reported for the period 1 July 2013–31 March 2014, 3 of which had students as the senior author. All other publication and presentation activities by PIs on awards that are continuing from NA08OAR4320751, are listed in Appendix 3 of the Year 6 report on that cooperative agreement.

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: 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 multi-disciplinary 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 multi-disciplinary cruises in 2009 and 2012 in the northern Bering and Chukchi Seas depending on resources.

During the current funding period, funds remaining in 3 of the original 5 competitively selected RUSALCA projects were deobligated from NA08OAR4320870 (a CIFAR shadow award) and moved to our current renewal cooperative agreement NA13OAR4320056. The delay in drawing down RUSALCA award funds resulted from the one-year postponement of the planned 2008 interdisciplinary Russian-American cruise. Also, as the project proceeded, the NOAA Arctic Research manager at the time requested that additional chemical measurements be made on the physical oceanography mooring retrieval cruises, which were made possible by using student involvement rather than permanent staff. While student research involvement is cost-effective for NOAA, it does extend the time line for delivery of research outcomes.

Goals of the RUSALCA program

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

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

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

Russell R. Hopcroft, Pl University of Alaska Fairbanks

CIFAR theme: Ecosystem Studies & Forecasting

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

NOAA Goals: Healthy Oceans; Climate Adaptation & Mitigation

CIFAR R13-04 New award that continues research from NA08OAR4320870 NOAA Office: OAR-CPO, Kathleen Crane, Sponsor

Primary objectives

Conduct a synthesis of recent zooplankton observations in the Chukchi Sea and over the past 30–50 years, specifically tackling the question: Can a climate change signal be detected for zooplankton in terms of major species or community structure? A key component of this analysis will be observations collected by the Russian-American Long-term Census of the Arctic (RUSALCA) program, and its precursor, the Bering Pacific (BERPAC) program. Additional information will be drawn from agencies, industry, and international scientists working in the Chukchi region.

Research accomplishments/highlights/findings

Zooplankton samples collected during the September 2012 cruise are now fully analyzed. Ershova has taken the lead on preparing the first 2 publications, one describing the zooplankton communities of the 3 primary cruises (plus 2 mooring cruises), and the second describing the egg production experiments executed on these cruises. Clear east-west and northsouth patterns are present and highly tied to water mass distribution. Results were presented at the 2013 PI meeting in St. Petersburg and the 2014 PI meeting in Honolulu.

Work continues to consolidate and unify existing planktonic data sets in the Chukchi region to better define the average pattern of zooplankton



communities as well as their scales of variability, and any long-term trends. Inter-annual variability is large. Analysis thus far finds there has not been any detectable change in the weight of zooplankton advected through Bering Strait since the mid-1980s.

NOAA relevance/societal benefits

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

Education

Elizaveta Ershova continues her Ph.D. under this project – she remains jointly supervised by Hopcroft and Kosobokova, and splits her time between UAF and Shirshov Institute, Moscow.

Outreach

Hopcroft, through ArcOD (Arctic Ocean Biodiversity Project), continues to develop webpages providing information on Arctic zooplankton and access to historical datasets: see http://www.arcodiv.org/. The species page concept has been expanded upon through a related fellowship by the Encyclopedia of Life to Ershova, that will be merged with ArcOD content over time.

Publications, conference papers, and presentations

Poster presentation

Ershova, E.A., R.R. Hopcroft and K.N. Kosobokova. 2014. The effect of temperature on the reproductive success of 3 species of *Pseudocalanus* in the Pacific Arctic. Ocean Sciences Meeting, Honolulu, Hawaii, February 2014.

Other products and outcomes

Hopcroft is working in conjunction with NOAA toward the development of a Circumpolar Biodiversity Monitoring Program (CBMP) under the International Arctic Council within which the RUSALCA program will represent a significant component from the USA. Hopcroft also provides oversight on the RUSALCA data management project.

Partner organizations and collaborators

Arctic Ocean Biodiversity Project (ArcOD)

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

Katrin Iken, PI Bodil A. Bluhm, PI University of Alaska Fairbanks CIFAR theme: Ecosystem Studies & Forecasting

Other investigators/professionals associated this project: *Ken Dunton, University of Texas at Austin NOAA Goals: Healthy Oceans; Climate Adaptation & Mitigation*

CIFAR R13-03 Continues research from NA08OAR4320870 NOAA Office: OAR-CPO, Kathleen Crane, 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/findings

During the reporting period, we completed sample processing of samples collected during the RUSALCA interdisciplinary research cruise on the R/V Khromov in August/September 2012. Samples collected for stable isotope analysis for the food web structure objective were processed (lipid extraction, carbonate removal, etc.) and measured at the Alaska Stable Isotope Facility, UAF. The focus was on samples from the southern Chukchi Sea stations, which had also been sampled during the 2004 and 2009 cruises (Figure 1), to provide the database of a temporal comparison of food web structure in that part of the study region. Vouchers of the epifaunal collections from 2012 were sorted and sent to taxonomic experts in the field. The newest taxonomic resolution for the 2012 epifaunal collections now includes 174 taxa. Both food web and epibenthic community structure data are part of M.S. student Carlos Serratos' thesis, and this report is based mostly on his analyses.



Figure 1. Map of the southern Chukchi Sea study region showing station locations sampled in all three study years (2004, 2009, 2012) for food web structure.

Food web structure

Stations sampled for food web structure in the southern Chukchi Sea were divided by their association with three water masses, the Alaska Coastal Water (ACW; stations CS17, CL1), the central Anadyr Bering Shelf Water (AW; stations CS4, CS8, CS12, CL3, CL6, CL8) and station CL10 along the Russian Coast (RC), which is under the occasional influence of the Siberian Coastal Current as well as under the freshwater outflow of a large coastal lagoon. Trophic level (TL) of organisms was determined using the δ^{15} N stable isotope ratio of particulate organic matter as a reference. TL distribution differed between the three water masses, with >80% of the organisms in ACW within the 3rd and 4th TL, while nearly 90% of all organisms in AW were within the 1st and 2nd TL. Organisms in RC were distributed between 1st to 4th TL with the majority in TL2 and 3 (Figure 2). This pattern, especially for ACW and AW, was very similar to that established for the same stations/water masses in 2009 (Figure 3) as well as 2004 (Iken et al. 2010). A notable difference was found in RC water where more organisms were found on a higher TL in 2009 than in 2012.



Figure 2. Trophic level distribution of benthic taxa in 2012 by water mass (for details see text).



Figure 3. Trophic level distribution of benthic taxa in 2009 by water mass (as in Figure 2).

Epifaunal community composition

Community composition in 2012 was grouped into several distinct clusters, based on abundance (Figure 4) and biomass (Figure 5).



Figure 4. Epibenthic community composition by phyla (pie charts) and clusters (circling stations) based on abundance in 2012.



Figure 5. Epibenthic community composition by phyla and clusters based on biomass in 2012. Cluster colors match station colors in Figure 6.

Abundance data revealed three clusters (hierarchical cluster analysis; within-group similarity 39-44%, between group dissimilarity 78–80%), with one northern, one southern and one shared cluster, plus several individual stations (Figure 4). The northern cluster was composed mostly of echinoderms and arthropods, each making up about 48% of the abundance at the northern stations. Among the arthropods, snow crab and shrimp were most abundant, while the mud star *Ctenodiscus crispatus* was the most prominent echinoderm in the northern cluster. The north-south shared cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly shrimp. The southern cluster was dominated by arthropods, mostly show crab and shrimp, but also several mollusks (the moon snail *Cryptonatica affinis* and the cockle *Serripes groenlandicus*) and echinoderms (the sea stars *Leptasterias* spp.). Community composition based on biomass distinguished two northern clusters and two southern clusters plus two individual southern stations (within group similarity 35–50%, between group dissimilarity 70–81%; Figure 5). The central northern cluster was vastly dominated by echinoderms (*Ctenodiscus crispatus*), while the second northern cluster ("North 2", black in Figure 5) stations was dominated by arthropods (*Chionoecetes opilio* and shrimp) and also the brittle star *Ophiura sarsii*. The south-eastern cluster in the ACW region was dominated by hermit crabs and shrimp, while the larger central

The following environmental variables from a per station basis were used to correlate with the biological biomass matrix to assess which variables may be particularly important in shaping the epibenthic community: bottom temperature, bottom salinity, bottom water oxygen concentration, latitude, depth, water column chlorophyll *a* and sediment chlorophyll *a* concentration, % gravel, % sand, % mud. As the single-best variable, % gravel explained ~51% of the epibenthic community variation (BIOENV analysis, Primer software). The only slightly higher explanatory power came from a 5-variable combination of % gravel, temperature, depth, water column chl *a*, and sediment chl *a*, explaining 52% of community structure. Stations based on the environmental variables grouped similarly in a Principle Component Analysis (PCA) (Figure 6) to the station clusters based on epibenthic biomass (as displayed in Figure 5). The first PCA axis was mostly related to sediment characteristics and explained 20% of the station variation. The grouping of stations based on environmental variables (Figure 6) matched well the station distinction based on biomass (station colors in Figure 6, based on cluster analysis shown in Figure 5), and indicated a separation of the two northern clusters mainly by sediment characteristics, while the southern clusters separated from the northern clusters and from each other mostly based on hydrographic conditions (Figure 6).



Figure 6. Station grouping based on environmental variables (Principle Component Analysis, see text for details on variables). Vector direction and length indicate direction along PCA1 and PCA2 as well as the relative strength of the variable, respectively, with the circle indicating maximum vector length. Station colors reflect cluster association in Figure 5.

Reference

Iken, K., B. Bluhm and K. Dunton. 2010. Benthic food-web structure under differing water mass properties in the southern Chukchi Sea. Deep-Sea Research II, 57:71–85.

NOAA relevance/societal benefits

This work will contribute 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 will be essential information to "understand the consequences of climate variability and changes" in the Chukchi Sea marine ecosystem. This work will provide 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.

Education

Carlos Serratos has been working on this project as a M.S. student in Marine Biology since fall semester 2012. His thesis objective is to compare epifaunal community and food web structure for the southern and central Chukchi Sea from 2004, 2009 and 2012. He has completed the required courses in the degree program and has done very well in his courses. He will take the comprehensive exam in May 2014. He measured all stable isotope data from 2012 and some missing samples from 2009 for the temporal comparison in the southern Chukchi Sea study region. He also underwent the labor-intense taxonomic matching of confirmed voucher names to spreadsheets and unifying epifaunal spreadsheets among the different sampling years. He also accumulated datasets of potential environmental drivers of the communities.

Carlos presented his results on epifaunal community structure from 2009 and 2012 in a poster at the Alaska Marine Science Symposium in January 2014 (see below). He also was awarded a Center for Global Change Student Research Competition award funded by CIFAR (NA08OAR4320751) that provided some summer salary in 2013 and 2014.

Outreach

Bluhm included findings from this RUSALCA project in her invited outreach presentation at the Sitka WhaleFest in October 2013. We also based part of a video-recorded interview for the upcoming *Sikuliaq* exhibition in the UAF Museum of the North on RUSALCA experiences and supplied photographic materials for the exhibit. [The R/V *Sikuliaq* is new 261-foot ice-capable research vessel owned by the National Science Foundation and operated by the UAF School of Fisheries and Ocean Sciences.]

Publications, conference papers, and presentations

Publications

No publications were produced during the reporting period, but the ongoing research will form the basis for (at least) two publications.

Oral presentations

- Bluhm, B.A., B.A. Holladay, F. Huettmann, K. Iken and B.L. Norcross. 2014. Demersal fish and epibenthic assemblages in the Chukchi Sea: observations and predictions. Ocean Sciences Meeting, Honolulu, Hawaii, 23– 28 February 2014.
- Bluhm, B.A., B.L. Norcross, K. Iken, F. Huettmann, B.A. Holladay and B.I. Sirenko. 2013. Fish and epibenthic assemblages in the Chukchi Sea: observations and predictions. Russian-American Long-Term Census of the Arctic Synthesis Meeting, St. Petersburg, Russia, 21–23 May 2013.
- Bluhm, B.A., K. Iken, C. Serratos and B. Sirenko. 2013. Temporal comparison of epifauna and food web in the southern Chukchi Sea (2004, 2009, 2012): First results. Russian-American Long-Term Census of the Arctic Synthesis Meeting, St. Petersburg, Russia, 21–23 May 2013.

Bluhm also contributed two very brief presentations to the RUSALCA PI meeting in Honolulu in February 2014. *Poster presentations*

- Serratos, C., B. Bluhm and K. Iken. 2014. Epibenthic community structure in the Chukchi Sea (RUSALCA 2009, 2012). Alaska Marine Science Symposium, Anchorage, Alaska, 20–24 January 2014.
- Søreide, J.E., K. Iken, B. Bluhm, R. Gradinger, P. Renaud, T. Tamelander, J.E. Tremblay, H. Hop, M. Carroll, W. Ambrose Jr., K. McMahon and K. Dunton. 2014. Stable isotope baseline values in marine food webs: a Pan-Arctic review. Ocean Sciences Meeting, Honolulu, Hawaii, 23–28 February 2014. [This presentation included POM data collected during the RUSALCA cruises]
- Divine, L., K. Iken and B. Bluhm. 2014. Alaskan Arctic snow crab diets: comparison of stomach content and δ^{13} C and δ^{15} N stable isotope analyses. Alaska Marine Science Symposium, Anchorage, Alaska, 20–24 January 2014. [This presentation included data on snow crab collected during the 2012 RUSALCA cruise]

- Ravelo, A.M., B. Konar, B. Bluhm and K. Iken. 2014. Size distribution and abundance of the dominant Arctic shelf brittle stars: *Ophiura sarsii* and *Ophiocten sericeum*. Alaska Marine Science Symposium, Anchorage, Alaska, 20– 24 January 2014. [This presentation included brittle data collected during the RUSALCA cruises]
- Renaud, P.E., M.K. Sejr, B.A. Bluhm, B. Sirenko and I.H. Ellingsen. 2014. Projected temperature-mediated range changes in Arctic and boreal benthic fauna. Alaska Marine Science Symposium, Anchorage, Alaska, 20–24 January 2014. [This presentation included species distribution data collected during the RUSALCA cruises]

Partner organizations and collaborators

Bluhm and Iken are both co-PIs of an ongoing NSF-sponsored Bering Sea Ecosystem Studies (BEST) project, which investigates pelagic-benthic coupling in the Bering Sea in relation to sea ice cover. The project relates to the RUSALCA objectives through the common focus on climate change research on Arctic shelf systems. Both PIs are involved with snow crab population and reproductive dynamics work in the Chukchi and Beaufort Seas (CMIfunded), which ties together with RUSALCA epifaunal community and food web structure objectives and sampling. Both PIs also are engaged in analyzing the food web structure on the Beaufort Sea shelf, and that of snow crab on the Chukchi shelf through isotope and stomach content analysis by advising a PhD student funded through the NSF-Integrative Graduate Education and Research Traineeship (IGERT) program MESAS (Marine Ecosystem Sustainability in the Arctic and Subarctic). This effort links intrinsically to the food web studies performed within the RUSALCA project on the Chukchi shelf. The continued funding for this student will be from the BOEM-funded Arctic Environmental Impact Study (EIS) project (Iken and Bluhm co-PIs) that focuses on fish and lower trophic level communities in the northern Bering and Chukchi Seas. 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 is funded through the Oil Spill Recovery Institute (OSRI) to rescue historic unpublished data from epifaunal trawl hauls in the Beaufort Sea. Bluhm is also a co-PI on the NPRB-funded Pacific Arctic Marine Regional Synthesis (PacMARS) project that aggregates and synthesizes research across multiple disciplines in the northern Bering, Chukchi and Beaufort Seas including RUSALCA efforts.

Iken and Bluhm also 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 the Chukchi Sea region. Iken is the US Benthic Marine Ecosystem Expert and Bluhm is the US Sea Ice Marine Ecosystem Expert for the implementation phase of the CBMP. 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 Russianauthored 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.

Changes/problems/special reporting requirements

With the involvement of a M.S. student, who has to complete required course work in addition to working on the research thesis, progress on sample and data analysis has been slowed down somewhat. We therefore are requesting a 1 year no-cost extension (in progress).

Continuation of RUSALCA fish ecology research

Brenda L. Norcross, PI University of Alaska Fairbanks CIFAR theme: Ecosystem Studies & Forecasting

Other investigators/professionals associated with this project: **Brenda A. Holladay, Co-PI,** University of Alaska Fairbanks **Morgan S. Busby,** Senior Investigator, Alaska Fisheries Science Center (AFSC), Seattle

NOAA Goals: Healthy Oceans; Climate Adaptation & Mitigation

CIFAR R13-01 Continues research from NA08OAR4320870 NOAA Office: OAR-CPO, Kathleen Crane, 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, we have made progress on four manuscripts described below. We also made progress working with our Russian colleagues to outline a synthesis publication: Temporal and Spatial Variability in fish communities of the Chukchi Sea, 2004–2012. Christine Gleason, who received her M.S. Fisheries Oceanography degree under Norcross in 2012, developed her thesis research based on specimens she collected during the 2009 RUSALCA cruise so is a lead author on two publications.

1. Gleason, Norcross. Tentative title: *Physical environmental and biological correlates of otolith chemistry of arctic marine fishes in the Chukchi Sea*. This includes trace element chemistry of fish otoliths and water samples collected throughout the Chukchi Sea during RUSALCA-2009. This manuscript has gone through several iterations. We expect to make one final revision and submit to Fisheries Research late April 2014.

The significant findings are as follows. Environmental variables and fish age correlated with Arctic cod and Arctic staghorn sculpin otolith signatures, while only environmental variables correlated with Bering flounder signatures. Elemental chemistries were different for Arctic cod captured from three bottom water masses and were correlated to temperature (Sr/Ca and Ba/Ca) and fish age (Mg/Ca and Sr/Ca). Elemental correlations were not always consistent for the variables tested among fish species. The complexity of this multi-element tool suggests otolith chemistry may not be useful to determine life history movement patterns of these demersal Arctic fishes in offshore waters unless sampled over a larger magnitude of environmental variables, e.g., a greater temperature range.

2. Gleason, Norcross, Holladay. Tentative title: Otolith chemistry of open water and nearshore fishes in the Chukchi Sea. This includes trace element chemistry of fish otoliths and water samples collected throughout the Chukchi Sea during RUSALCA-2009 and in the nearshore northeastern Chukchi Sea during the Alaska Monitoring and Assessment Program (AKMAP) 2010 cruise. Otoliths from fishes collected over a broader range of environmental parameters than manuscript 1 form the basis of this research. Samples have been processed for trace elements, and preliminary statistical analyses have been completed. We are on track to submit the draft for peer review by July 2014.

3. Busby, Norcross, Holladay. Tentative title: Abundances and diversity of ichthyoplankton from surveys in the Chukchi Sea 2004–2012. This includes 2004, 2009, and 2012 RUSALCA cruises. The three investigators discussed this paper at the RUSALCA meeting in Honolulu in February 2014 and will meet for a working session during April. We expect to complete a draft in July 2014.

4. Bluhm, Holladay, Huettmann, Iken and Norcross. Tentative title: 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 was completed in December 2013. More iterations are needed before this is ready to submit to a journal.

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.

Publications, conference papers, and presentations

Oral presentations

Bluhm, B.A., B.A. Holladay, F. Huettmann, K. Iken and B.L. Norcross. 2014. Demersal fish assemblages in the Chukchi Sea: observations and predictions. Ocean Sciences Meeting, Honolulu, Hawaii, February 2014.

- Chernova, N.V., B.A. Holladay, C.W. Mecklenburg, B.L. Norcross and E.P. Voronina. 2014. Temporal and spatial variability in fish communities of the Chukchi Sea, 2004-2012 preliminary conclusions. RUSALCA PI Meeting, Honolulu, Hawaii, February 2014. (presented by Norcross)
- Norcross, B.L., B.A. Holladay, M. Busby and C.M. Gleason. 2013. Small demersal fishes and ichthyoplankton: Ecology and community structure. RUSALCA PI Meeting, St. Petersburg, Russia, May 2013.

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

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

CIFAR theme: Ecosystem Studies & Forecasting

NOAA Goals: Healthy Oceans; Climate Adaptation & Mitigation

CIFAR R13-02 Continues research from NA08OAR4320870 NOAA Office: OAR-CPO, Kathleen Crane, 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.

- Analysis of nutrient, chlorophyll, and primary production samples.
- Data for nutrients, chlorophyll and primary production will be sent to designated archive for inclusion in the RUSALCA database.
- Data products will be prepared for presentation at one or two planned RUSALCA workshops.
- 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 three manuscripts will be prepared that emphasize physical-nutrient processes, nutrient-primary productivity processes, and nutrient-primary production-microbial processes.

Research accomplishments/highlights/findings

- Primary production rate measurements using carbon and nitrogen isotopes were collected at six light depths on 21 stations. The samples will be analyzed by mass spectrometry after data is cleared and released by Russian authorities.
- Analysis of the nutrient and primary production data in relation to prior RUSALCA measurements and historic data collected by prior programs were combined in a draft manuscript that is planned for publication in the dedicated issue of RUSALCA papers.

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

The Ph.D. student formally supported by this grant withdrew from his degree program due to medical reasons. The student's research program on primary production and nutrient dynamics is being completed by technical and research staff.

Changes/problems/special reporting requirements

The main problem encountered this reporting period revolves around the unexpected withdrawal of the Ph.D. student, Michael Kong, from his program due to medical reasons. This resulted in a major reorganization of sample analysis plans and a delay of several months in the sample analysis. The delay was mainly due to the uncertainty of whether the student would be able to continue as he stated or withdraw. This hurdle is now past so the project is expected to be resumed at the original rate.

Publications related to this project as funded under previous CIFAR cooperative agreements

Peer-reviewed

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

RUSALCA data management

Russell Hopcroft, Pl University of Alaska Fairbanks CIFAR theme: Ecosystem studies and forecasting

NOAA Goals: Healthy Oceans; Climate Adaptation & Mitigation

CIFAR R13-10 Continues research from NA08OAR4320751 NOAA Office: OAR-CPO, Kathleen Crane, Sponsor

Primary objectives

In support of the Russian-American Long-term Census of the Arctic (RUSALCA) research projects, NOAA has provided support for digitally archiving data from all disciplines to 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 to access only by principal investigators for certain periods of time.

The project objectives are:

<u>Data Consolidation</u> - 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.

<u>Web Interface</u> - 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.

<u>Data Distribution</u> - 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

Complications in setting up the subaward for Axiom (final execution in March 2014), has prevented significant progress on this project. Most reporting will be deferred to the next reporting period.

Representatives from Axiom attended the RUSALCA PI meeting in February 2014, where they demonstrated the workspace and beta versions of several data exploration tools. A number of datasets were secured from the PIs at that time.

NOAA relevance/societal benefits

- This project provides the data infrastructure to examine the potential impacts of climate change in the Pacific-Arctic gateway.
- It will place RUSALCA data into public domain, as well as distribute 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. AOOS is becoming the major repository for many other datasets for the Pacific-Arctic region from agencies, industry and academia.

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, Pl University of Alaska Fairbanks CIFAR theme: Ecosystem Studies & Forecasting

NOAA Goal: Healthy Oceans

CIFAR R13-06. This project is new.

NOAA Office: NMFS:AFSC, Chris Rooper, Sponsor

Primary objectives

The Alaska Deep Sea Coral and Sponge Initiative (AKCSI) is 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 addresses 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, will collaborate 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. The potential habitat maps will be based on the compiled and georeferenced bathymetry, sonar and sediment data layers from AKCSI collaborators; groundtruth from any available seafloor video and still photo imagery; and geological interpretation that takes into account the bedrock and tectonic patterns, sediment type and depth, oceanography, and seafloor morphology at the highest resolution available. Geologic interpretation is used to understand a suite of seabed characteristics in terms of the processes that create them, and to use this understanding to extrapolate seabed characteristics in poorly sampled areas. These maps may then be combined with other types of information, e.g., bycatch in bottom trawls, for predictive modeling of species distribution.

Research accomplishments/highlights/findings

Jennifer Reynolds met with Alaska Coral and Sponge Initiative collaborators at the Alaska Fisheries Science Center (Seattle) on September 26–27, 2013. Meeting participants reviewed progress on the Alaska Coral and Sponge Initiative and planned for FY14.

NOAA relevance/societal benefits

The goal of NOAA's exploration and research on deep-sea coral and sponge ecosystems is to provide decisionmakers with sound scientific information that will enable effective ecosystem-based management decisions. Research activities in Alaska will provide 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 throughout most of Alaska's marine waters. In some places, such as the western Aleutian Islands, these may be the most abundant cold-water coral and sponge communities in the world. Deep sea coral and sponge communities are associated with many different species of fishes and invertebrates in Alaska. For example, the consistent association of sponges and corals with juvenile Pacific ocean perch (*Sebastes alutus*) may imply better growth or survival in these habitats. The challenges facing management of deep coral and sponge ecosystems in Alaska begin with the lack of knowledge of where these organisms occur in high abundance and diversity.

Two critical information needs developed by stakeholder participants at the NOAA Deep-Sea Coral and Sponge Ecosystems Exploration and Research Priorities Workshop for Alaska (September 2010):

- Mine existing knowledge to expand our understanding of deep-sea coral and sponge distribution.
- Implement a regional rather than "postage stamp" approach to deep-sea coral studies.

This project uses existing, archived data as well as new data collected through the Alaska Coral and Sponge Initiative, to determine which areas may contain valuable and potentially vulnerable deep-sea corals and sponges. The product, a regional-scale benthic habitat map, will be the first such map covering large areas of Alaskan waters and will be specifically developed to identify potential locations of deep-sea corals and sponges.

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

Thomas Heinrichs, PI University of Alaska Fairbanks

CIFAR theme: Climate Change & Variability

Other investigators/professionals funded by this project: *Eric Stevens, Jiang Zhu, Jay Cable, Scott Macfarlane, Will Fisher, Dayne Broderson, University of Alaska Fairbanks*

NOAA Goal: Climate Adaptation & Mitigation

CIFAR R13-08 Continues research from NA08OAR4320751

NOAA Office: NESDIS, Ingrid Guch, Sponsor

Primary objectives

The objective of this activity is to build upon the already established collaborative team of National Aeronautics and Space Administration (NASA) Short-term Prediction and Research Transition (SPoRT), NOAA National Weather Service (NWS) Alaska Region, University of Alaska Fairbanks Geographic Information Network of Alaska (GINA), and NOAA National Environmental Satellite, Data, and Information Service (NESDIS) to improve readiness of forecasters to use the Suomi National Polar-orbiting Partnership (NPP) and Joint Polar Satellite System (JPSS) Environmental Data Records (EDRs, http://jointmission.gsfc.nasa.gov/science/DataProducts.html) in a real-time operational forecast environment. Other NOAA cooperative institute partners include the University of Wisconsin Madison Cooperative Institute for Meteorological Satellite Studies (CIMSS) and the Colorado State University Cooperative Institute for Research in the Atmosphere (CIRA).

In Alaska, the primary focus will be on the atmosphere and cloud products that can be used to address forecasting issues. Additional emphasis will be placed on products such as sea surface temperatures (SST), ocean color, sea ice characterization, snow cover, low light visibility, and red-green-blue composites. Results on the test and evaluation of the NPP/JPSS products will be shared with other NWS Regions. Forecaster feedback will be shared with algorithm developers and this feedback loop will result in enhanced utility of polar EDRs.

The overall goal for this project: Alaska NWS weather, aviation, and river forecasters have adopted NPP data products within a year of launch, leading to improved warnings and forecasts, and forecasters are eagerly anticipating JPSS launch and future products.

- 1. Rapid adoption of NPP/JPSS EDRs into Alaska NWS operations.
- 2. Delivery of customized, high-latitude-specific products to NWS operations.

Project accomplishments/highlights/findings

 GINA Puffin Feeder provides Visible Infrared Imaging Radiometer Suite (VIIRS) products for use by the Alaska NWS Ice Program. VIIRS products are being produced in near-real-time in Geographic Tagged Image File Format (GeoTIFF) formats to support NWS sea ice forecasting. This product format is what is needed by the Geographic Information Systems (GIS) used by the ice forecasters to chart ice. Adoption of the VIIRS imagery products has been strong by the ice desk. http://feeder.gina.alaska.edu. Examples are shown below (Figures 1 and 2)



Figure 1. An example screen shot of a NWS Alaska sea ice analyst's work environment. VIIRS imagery is a key information input from the Suomi National Polar-Orbiting Partnership (SNPP).



Figure 2. Special VIIRS band combinations that help NWS Alaska sea ice analysts by creating contrast among clouds, snow, and sea ice.

2. Supplied VIIRS 105 longwave infrared band for NOAA National Ice Center (NIC). GINA received a request from the NOAA National Ice Center to add the VIIRS 105 longwave infrared channel to the GINA Puffin Feeder. The NIC had been using other georeferenced satellite imagery from the Feeder and requested the enhancement to the service to support ice forecasting at the National Center. (Figure 3)



Figure 3. Sample of VIIRS 105 longwave infrared imagery provided in near real time to the NOAA National Ice Center and Alaska NWS Sea Ice Program.

GINA-WRF (Weather Research & Forecasting) model was configured to include two domains. The coarse domain with 18 km resolution covers the whole Alaska region and a nested domain with 6 km resolution covers the Fairbanks area. The GSI (gridpoint statistical interpolation) 3d-var data assimilation scheme was used in the experiments. GFS forecast were used as initial condition. Only the best quality AIRS/CrIS (Atmospheric Infrared Sounder / Cross-track Infrared Sounder) sounder profile data were assimilated. The model runs in cycling mode with 12-hour spin-up time. Satellite sounder profile data was brought in every 6 hours. Many case studies and a one-month continuous run were done. The initial conclusions were: while the sounder profile data does improve the initial conditions for the GINA-WRF model, the positive impact to forecast is localized and short-term. The degree of impact changes with variables.

We want to continue this research in the following two directions: 1. Bring more satellite data into the cycling WRF model run. 2. Test different data assimilation schemes to further improve the weather forecast accuracy.

3. Participated in 2013 NOAA Satellite Conference.

Tom Heinrichs and Eric Stevens represented GINA at the 2013 NOAA Satellite Conference in College Park, Maryland in April 2013. Eric was lead author and presented a poster on the topic, "Suomi NPP VIIRS Imagery and the Grounding of the Oil Platform Kulluk in Alaska." Tom Heinrichs presented a poster, "Use of GOES-R Imagery in the Detection Volcanic Ash and the Production of Aviation Warnings in Alaska."

4. Participated in CSPP/IMAPP Users Group Meeting

Scott Macfarlane and Eric Stevens represented GINA at the CSPP/IMAPP Users Group Meeting in Madison, Wisconsin in May, 2013, where CSPP is the Community Satellite Processing Package and IMAPP is the International MODIS (or Moderate-resolution Imaging Spectroradiometer)/AIRS Processing Package (IMAPP). Scott gave a presentation on the topic, "CSPP and IMAPP Real-Time Processing in Alaska." 5. Helped organize and hosted OCONUS meeting

GINA staff, in collaboration with NWS Alaska and the Satellite Proving Ground, organized and hosted the OCONUS (Outside (the) contiguous United States) meeting held in Anchorage and Fairbanks in June 2013. Representatives of CIMSS, CIRA, and SPoRT attended, as well as program managers from the satellite proving grounds. GINA staff gave several presentations during the conference.

- 6. Began producing NASA SPORT's RGB (red, green, blue color model) Night-Time Microphysics products from VIIRS and MODIS data on virtual machines at GINA for use by National Weather Service offices in Alaska. With the motivation to deliver SPORT's RGB NT-Micro product to Alaskan NWS offices with minimal latency, it was proposed that GINA host virtual machines (VMs), thereby eliminating the delay incurred in shipping the products from Alabama to Alaska. The hoped-for improvements in latency have only been partially realized, however, due to the slowness of the VMs at GINA. Work is ongoing to make the VMs run as efficiently as possible. SPORT staff involved in this effort includes Kevin Fuell, Matt Smith, and Kevin McGrath.
- 7. Collaborated with SPoRT to evaluate RGB Night-Time Microphysics product by NWS offices in Alaska from December 2013 through February 2014.

Kevin Fuell and staff at NASA SPORT produced a "Quick Guide" document and an "Articulate Presentations" module as training resources for use by NWS in Alaska. Eric Stevens of GINA provided input to SPORT during the development of these training materials and traveled to NWS Anchorage in early December to speak with forecasters and NWS management about the evaluation. Links to the training materials area available on SPoRT's web site at http://weather.msfc.nasa.gov/sport/training



Figure 4. Screen capture from AWIPS2 at WFO Fairbanks showing the RGB Night-Time Microphysics product generated from SPoRT software run on virtual machines at GINA and delivered via LDM from GINA to NWS Alaska

8. Worked with CIMSS on CrIS update to CSPP Polar2Grid.

GINA's Scott Macfarlane collaborated with staff at CIMSS on the pending update to the CSPP code which will allow production of products from CrIS data. Staff involved at CIMSS includes Kathy Strabala, Elisabeth Weiss, and David Hose. Implementation of this update is expected in second quarter 2014.

- Participated in the SNPP SDR review in December Eric Stevens of GINA gave a presentation, "Use of VIIRS by the National Weather Service in Alaska" at the "Suomi NPP Science Data Record (SDR) Science and Products Review" held in College Park, Maryland.
- 10. Recorded a segment for the "Alaska Weather" television program on the topic of the VIIRS Day-Night Band In December, staff at the National Weather Service in Anchorage recorded an interview with Eric Stevens of GINA on the topic of the VIIRS Day-Night Band and its use in weather forecasting in Alaska. This segment was broadcast state-wide in Alaska in February 2014 as part of the public television program, "Alaska Weather" produced by studio KAKM in Anchorage. This segment is also available on the JPSS web site at www.jpss.noaa.gov/video_gallery.html
- 11. Began participation in a project to develop and use VIIRS imagery during flood events in the spring "breakup" period.

GINA, under the leadership of the JPSS Program Office and in collaboration with George Mason University, the City College of New York, the National Weather Service's North-Central River Forecast Center and Alaska-Pacific River Forecast Center, contributed to the development of new products to be produced from VIIRS data and used by the River Forecast Centers (RFCs) to identify areas of over-land flooding during floods in the spring "breakup" period along the Red River of the North and the Yukon River. It is expected that the resulting products will be available to the NWS in Alaska during the breakup period of 2014 beginning in April.

- 12. GINA staff presented JPSS work at the annual meeting of the American Meteorological Society. Jiang Zhu and Eric Stevens of GINA attended the annual meeting of the American Meteorological Society (AMS) in Atlanta, Georgia in February 2014. Jiang was lead author and presented a poster, "Satellite Sounder Data Assimilation for Improving Alaska Region Weather Forecast." Eric Stevens gave an oral presentation on the topic, "Use of VIIRS Imagery by the National Weather Service in Alaska."
- 13. Met NOAA Satellite Liaisons and CIMSS staff. Eric Stevens traveled to Madison, Wisconsin in March 2014 to meet with the NOAA Satellite Liaisons and staff at CIMSS. Eric gave a PowerPoint presentation on Proving Ground activities at GINA and in NWS Alaska Region and also had several one-on-one meetings with CIMSS staff to discuss projects relevant to Alaska.

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.

Publications and presentations

Oral presentations

- Stevens, E. 2013. Alaska Region satellite product and data needs Near-term and longer term future needs. NOAA-NESDIS OCONUS meeting, Anchorage and Fairbanks, Alaska, 17–21 June 2013.
- Stevens, E. 2013. Use of VIIRS by the National Weather Service in Alaska. Suomi NPP SDR Science and Products Review, College Park, Maryland, 18–20 December 2013.
- Stevens, E. 2014. Use of VIIRS imagery by the National Weather Service in Alaska. American Meteorological Society meeting, Atlanta, Georgia, 2–6 February 2014.

Poster presentations

- Stevens, E. and J. Nelson. 2013. Suomi NPP VIIRS imagery and the grounding of the oil platform Kulluk in Alaska. NOAA Satellite Conference for Direct Readout, GOES/POES, and GOES-R/JPSS Users, College Park, Maryland, 8–12 April 2013.
- Heinrichs, T., E. Stevens and N. Eckstein. 2013. Use of GOES-R imagery in the detection of volcanic ash and the production of aviation warnings in Alaska. NOAA Satellite Conference for Direct Readout, GOES/POES, and GOES-R/JPSS Users, College Park, Maryland, 8–12 April 2013.
- Zhu, J., E. Stevens, B.T. Zavodsky, X. Zhang, T. Heinrichs and D. Broderson. 2014. Satellite sounder data assimilation for improving Alaska Region weather forecast. American Meteorological Society meeting, Atlanta, Georgia, 2–6 February 2014.

Outreach

Stevens, Eric. Video segment recorded for Alaska Weather news show regarding SNPP VIIRS Day-Night Band. Broadcast in February 2014. www.jpss.noaa.gov/video_gallery.html

Other products and outcomes

GINA staff worked with NASA Direct Readout Laboratory personnel and the Alaska Volcano Observatory (AVO) to process SNPP OMPS (Ozone Mapping and Profiler Suite) instrument and derive ozone, aerosol, SO₂, and volcanic ash products to support AVO and the Alaska NWS Aviation Weather Unit.

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

COASTAL HAZARDS

UAS survey of marine debris generated by the 2011 Japanese tsunami

Gregory Walker, PI* University of Alaska Fairbanks

CIFAR theme: Coastal Hazards

NOAA Goal: Healthy Oceans; Weather Ready Nation

*Change of PI request to Marty Rogers had not been approved by 4/21/14 when this report was finalized.

CIFAR R13-11 Continues research from NA08OAR4320751 NOAA Office: OAR, Robbie Hood, Sponsor

Primary objectives

The objective of this project is to continue using two different small Unmanned Aerial Systems (UAS) to search and map the location, type, distribution, and movement of marine debris originating from the March 11, 2011 Japanese tsunami. This project will provide characteristics of the tsunami debris that potentially threatens shipping, wildlife, and beaches/coral reefs, and will yield results generally applicable to marine debris surveys with small unmanned aerial systems. In addition to the science objective, we will: (1) experiment with sensor payloads and anomaly detection algorithms to find a combination of cameras, channels and detection methodology that can reliably detect debris (including derelict fishing gear) at or near the ocean's surface under a wide range of wind, wave, and illumination conditions; (2) determine an efficient and effective UAS marine debris survey; (3) obtain extensive flight experience with two UAS systems (Resolution and Puma) to allow a comparison of their capabilities.

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. Additionally, we have been working with the NOAA Aircraft Operations Center (AOC) to arrange for flight opportunities and for ship opportunities to be used by the NOAA Marine Debris Program for deployment of UAS, and we supported a field mission on Kodiak Island in September 2013.

The UAF Subcontractor ATI has been developing a suitable imager for this project. The camera that they were working with was the compact USB 2.0 powered Mightex SCE-CG04-U which was controlled by OpenIRiS ("Integrate. Relate. Infer. Share") anomaly detection software. This camera has been replaced by the Samsung NX-210. This is a mirrorless camera with the following specifications:

- 20.3 Mp Image Capture
- 18-55mm (3x) Zoom Lens
- Large (23.5 x 15.7mm) APS-C (Advanced Photo System type C) Image Sensor
- Full HD 1080p Stereo Video Capture
- Instant Sharing via Wi-Fi
- 3.0" VGA AMOLED (Active-Matrix Organic Light-Emitting Diode) Display
- High Speed 8.0 fps Capture
- Smart Auto and Filter 2.0
- 2D/3D Panorama Capable

One of the challenges regarding use of various sensors on UAS is the rapid entry of improved technology into the market. So, in some cases by the time the payload integration process is completed the sensor has been updated/improved and can be perceived as obsolete. ATI is currently reviewing newer sensor technology and plans on settling on a "final" sensor package by mid-2014.

Second Field Program – Kodiak Island September 24-26, 2013

Completed - Resolution test flights in Minnesota and Flight Report – ATI Completed - Certificate of Operation for Kodiak – UAF Completed - Operations Plan, CONOPS (Concept of Operations) Details, and Operational Risk Management Assessment – Bill Pichel (NOAA project PI), UAF, ATI, AOC, ESRL (NOAA Earth System Research Laboratory), NOAA Marine Debris Program, NOAA UAS Program Office

Completed - Waiver Request for Supplemental Pilot - Pichel, ATI, UAF

Completed - Flight Readiness Review and Mission Readiness Review 9/18/13 – AOC, Pichel, UAF, ATI, NOAA UAS Program Office

Completed - Puma Enhanced Sensor Tests in Arctic – UAF

Three complications prevented field program on Kodiak Island -

- 1. Weather did not allow participants to fly to Kodiak from Anchorage and bad weather all week led to cancellation of field program
- 2. Waiver of FAA Ground School and physical for Curt Olson as Supplemental Pilot was not approved by AOC.
- 3. Enhanced Puma sensor was not ready to fly on NOAA Puma

Completed - Kodiak Mission Report on Resolution testing and preparations for Kodiak Field Program – ATI

Completed - Performance tests for UAS that lands in water were conducted in Wasilla after Kodiak field program was cancelled – ATI

UPCOMING EFFORTS

Resolution Demonstration at AOC – Dates to be determined

Completed - Subcontract between UAF and ATI for second year of project – UAF, ATI Completed - FAA Ground School – ATI (Curt Olson) Complete FAA physical – ATI (Tim Veenstra and Curt Olson) Arrange for use of range in Florida for demonstration flights – AOC Preparation of documents required for demonstration flights – AOC, ATI Travel to Florida for Demonstration Flights – ATI, Pichel Demonstration Flights – ATI, AOC, Pichel Flight Report – ATI

Final Field Program for Project – Early June 2014 or September 2014

Completed - Developed and submitted proposal in response to call for proposals for 5 free days at sea on a NOAA ship – Pichel

- Completed Proposal for 5 free days at sea on a NOAA ship was accepted, but ship time was moved from May to September
- Decide location for final field program Kodiak, Channel Islands Sanctuary, NOAA Ship Shimada or elsewhere UAF, ATI, UAS Program Office

Decide whether field program will be for Resolution only or will include Puma – ATI, UAF, AOC, UAS Program Office

Arrange for airspace use, if necessary – Participants depend on location

Arrange for use of vessel – Participants depend on location

Complete Operations Plan, CONOPS Details, and Operational Risk Management Assessment – Pichel, UAF, ATI, AOC, ESRL, Marine Debris Program, NOAA UAS Program Office

Complete Flight Readiness Review and Mission Readiness Review – AOC, Pichel, UAF, ATI, NOAA UAS Program Office, Marine Debris Program

Compete Field Program – ATI, UAF, Pichel

Analyze UAS data – ATI

NOAA relevance/societal benefits

Over the past 6 years, NOAA has developed an active and effective marine debris capability led by the Marine Debris Program in the National Ocean Service (NOS) Office of Response and Restoration. This UAS project is directly relevant to the NOAA Marine Debris Program and its mission to research, prevent, and reduce marine debris impacts. Tracking and reduction of marine debris helps reduce maritime hazards and helps improve the health of our coastal environments.

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. 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.

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

Peter Webley, Pl Martin Stuefer, Pl University of Alaska Fairbanks CIFAR theme: Coastal Hazards

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

NOAA Goal: Weather Ready Nation

CIFAR R13-09 Continues research from NA08OAR4320751 NOAA Office: NESDIS, Ingrid Guch, Sponsor

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/findings

For the past year, we continued our comparisons between satellite-derived volcanic ash retrievals and the WRF-Chem volcanic ash transport model. We added in the capability to perform analysis with sulfur dioxide for volcanic eruptions. The aim was to provide a systematic assessment of the merit of the volcanic WRF-Chem simulations using GOES-R like products. These methodologies will be applicable operationally where WRF-Chem model simulations for active volcanoes can be evaluated against the GOES-R AWG (Algorithm Working Group) ash retrievals from Day 1 of the GOES-R products. We (1) completed the Redoubt 2009 and Eyjafjallajökull 2010 analysis for two publications; (2) furthered the satellite to model comparisons for Kasatochi 2008 and Sarychev Peak 2009 eruptions; (3) completed our Multi-angle Imaging Spectro-Radiometer (MISR) analysis (Ekstrand et al. 2013); and (4) continued development of WRF-Chem for sulfur dioxide/sulfate (SO_2/SO_4^{2-}) comparison to satellite data.

Student Torge Steensen completed his analysis of WRF-Chem as well as the Puff dispersion model as compared to satellite remote sensing for his Ph.D. thesis. The Steensen et al. (2013) publication compared volcanic ash retrievals with WRF-Chem model simulations from two events during the 2009 Redoubt eruptions. In addition, Stuefer et al. (2013) was published as a Geoscientific Model Development (GMD) Discussion paper. The paper provides a technical description of the implementation of volcanic source parameters and a volcanic eruption model in WRF-Chem.

We have furthered our analysis of volcanic eruptions by performing analysis with WRF-Chem of the eruption from Sarychev Peak, Kuriles in June 2009. This had 23 different events as detected in the remote sensing data and we have focused on four of these events. Torge Steensen continued to develop his system to carry out point to point analysis with the satellite retrievals as well as build a spatial comparison tool, or Merit of Space. This is a publication in prep by Steensen et al. for submission to *Journal of Volcanology and Geothermal Research* (working title "Quantitative comparison of volcanic ash observations in satellite-based remote sensing data and WRF-Chem model simulations").

For the SO₂ analysis, we continued WRF-Chem simulations as well as OMI (Ozone Monitoring Instrument) UV satellite retrievals. Our aim was to assess the model's capability to perform SO₂ simulations as well as the sulfur dioxide (SO₂) into sulfate (SO₄²⁻) conversion. There is an option 2 GOES-R SO₂ product and although there is no operational required advisory for SO₂, there are cases such as Hawaii where knowledge of the erupting SO₂ and its forecasted location is important for the local NWS office to provide advice upon. WRF-Chem with the inline Numerical Weather Prediction Model (NWP) and chemistry provides a unique tool over other SO₂ forecasting tools. A publication is in preparation by Egan et al. (working title "Modeling and remote sensing of the 2008 Kasatochi sulfur dioxide (SO₂) plume").

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.

Education

Torge Steensen

Ph.D. student in Geophysics (completed August 2013)

Role on project: Determine volcanic ash retrievals and comparison to the WRF-Chem and Puff Volcanic ash models. Build tool to compare satellite data to the modeled three-dimensional ash cloud

Sean Egan

Ph.D. candidate student in Environmental Chemistry

Role on Project: Comparison of WRF-Chem SO₂ 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.

Publications, conference papers, and presentations

Peer-reviewed publications

- Stuefer, M., S.R. Freitas, G. Grell, P. Webley, S. Peckham, S.A. McKeen and S.D. Egan. 2013. Inclusion of ash and SO₂ emissions from volcanic eruptions in WRF-CHEM: Development and some applications. *Geoscientific Model Development*, 6(2):457–468. doi:10.5194/gmd-6-457-2013
- Ekstrand, A., P.W. Webley, M.J. Garay, J. Dehn, A. Prakash, D.L. Nelson, K.G. Dean and T.S. Steensen. 2013. A multi-sensor plume height analysis of the 2009 Redoubt eruption. *Journal of Volcanology and Geothermal Research*, 259:170–184. http://dx.doi.org/10.1016/j.jvolgeores.2012.09.008
- Steensen, T., M. Stuefer, P.W. Webley, G. Grell and S. Freitas. 2013. Qualitative comparison of Mount Redoubt 2009 volcanic clouds using the PUFF and WRF-Chem dispersion models and satellite remote sensing data. *Journal of Volcanology and Geothermal Research*, 259:235–247. http://dx.doi.org/10.1016/j.jvolgeores.2012.02.018
- McNutt, S.R., G. Thompson, M.E. West, D. Fee, S. Stihler and E. Clark. 2013. Local seismic and infrasound observations of the 2009 explosive eruptions of Redoubt Volcano, Alaska. *Journal of Volcanology and Geothermal Research*, 259:63–76. http://dx.doi.org/10.1016/j.jvolgeores.2013.03.016

Poster presentations

Egan, S. and M. Stuefer. 2013. Modelling and remote sensing of ash and sulfur dioxide from the 2008 Kasatochi Volcano eruption. American Geophysical Union (AGU) fall meeting, abstract V43B-2886, December 2013.

- Stuefer, M., P. Webley, G. Grell, S. Freitas, C.K. Kim and S. Egan. 2013. Volcanic ash transport integrated in the WRF-Chem model: a description of the application and verification results from the 2010 Eyjafjallajökull eruption. European Geophysical Union (EGU) General Assembly. Id: EGU2013-6502, 7–12 April 2013.
- Egan, S. and M. Stuefer. 2013. Modeling and remote sensing of volcanic sulfur dioxide. European Geophysical Union (EGU) General Assembly. Id: EGU2013-6533, 7–12 April 2013.

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

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 shown 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 the VAAC office and Alaska Meteorological Watch Office and Alaska Aviation Weather Unit.

Alaska Earthquake Information Center seismic station operations and maintenance (CRESTnet)

Michael West, Pl

University of Alaska Fairbanks

Other investigators/professionals associated with this project: Christopher Bruton, Scott Dalton, Ian Dickson, Sharon Hansen, Dara Merz, Sara Meyer, Natalia Kozyreva University of Alaska Fairbanks

CIFAR R13-07 Continues research from NA08OAR4320751 NOAA Office: NOAA Tsunami Program, Michael Angove, Sponsor

Alaska CRESTnet (Consolidated Reporting of Earthquakes and Tsunamis)

Primary objectives

- Maintain Alaska Tsunami Center and Observatory (ATCO)- and CREST-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 West Coast and Alaska Tsunami Warning Center (WC/ATWC) and Emergency Managers.
- Maintain data flow of selected stations to ATWC.

Research accomplishments/highlights/findings

We continued to upgrade and expand our integrated seismic network, including the following work on ATCO- and CREST-funded stations:

- At ATKA, we replaced the compromised seismic vault with a new, sealed vault coupled to bedrock.
- At COLD (Coldfoot), we swapped in new batteries and made other improvements to the power system.
- At DCPH (Deception Hills, south of Yakutat), we installed new broadband and strong motion sensors and swapped in new backup batteries.
- At DIV (Divide Microwave, on Richardson Highway, 15-20 miles north of Valdez), we upgraded to digital telemetry and installed a Q330 datalogger, replaced antenna cabling, swapped in a new broadband sensor, and connected the site to state internet. However, we still have networking issues to resolve with the state, so we are not receiving data from DIV.
- At PAX (Paxson), we swapped in a new broadband sensor and removed trash and old batteries.
- At PIN (Pinnacle), we replaced two solar panels and removed trash from the site.
- At PPLA (Purkeypile, south of Denali National Park), we swapped in new broadband and strong motion sensors and replaced all batteries.

Between 1 April 2013 and 20 March 2014, Alaska Earthquake Center reported 28,955 events, with magnitudes ranging between -0.4 and 7.0 and depths between 0 and 290 km (Figure 1). Six earthquakes had magnitudes 6 or greater. The largest earthquake, of magnitude 7.0, occurred on 30 August 2013, in the Andreanof Islands region of Alaska.

NOAA relevance/societal benefits

Improved detection of tsunamigenic earthquakes by Alaska Earthquake Information Center (AEIC) and NOAA tsunami warning centers.

Outreach

AEIC continues to provide real-time and reviewed earthquake information to local emergency services offices through monitoring systems installed in the following population centers in the state: Fairbanks, Anchorage, Valdez, Seward, Soldotna, and Kodiak. The system resides on a stand-alone MAC computer that displays real time earthquakes on a state map with audio announcements of earthquake locations and magnitudes.



Figure 1. AEIC Seismicity Report for 1 April 2013 – 31 March 2014.

Appendices

- 1. Awards made through CIFAR (p. 27)
- 2. Personnel (p. 29)
- **3. Index of PIs** (*p. 31*)

Appendix 1 CIFAR Awards in Cooperative Agreement NA13OAR4320056 1 July 2013 to 31 March 2014 (Renewal Year 1)

				Project	Theme	Funding	Program
Last	First	Proposal Title	Amend	Budget	Description	Source	Manager
	Task 1 Activities: CI Administration and Education & Outreach						
Sugai	Susan	Regional Alaska Cooperative Institute (2013–2014)	0	\$10,000	Administration	OAR	Sabine
Sugai	Susan	Cooperative Institute for Alaska Reseach (CIFAR) renewal (2013-2018)	5	\$100,000	Administration	OAR	Crane
	-	NOAA Non-Competitive Awards (NA13OAR4320	056)				
Norcross	Brenda	Continuation of RUSALCA Fish ecology research	1	\$73,400	Ecosystem Studies & Forecasting	OAR	Crane
Whitledge	Terry	RUSALCA: Global change in the Arctic: Interactions of productivity and nutrient processes in the northern Bering and Chukchi Seas	2	\$105,748	Ecosystem Studies & Forecasting	OAR	Crane
lken	Katrin	RUSALCA: Arctic food web structure and epibenthic communities in a climate change context	3	\$99,672	Ecosystem Studies & Forecasting	OAR	Crane
Hopcroft	Russell	A synthesis of long-term observations of Pacific-Arctic zooplankton communities	4	\$92,001	Ecosystem Studies & Forecasting	OAR	Crane
Reynolds	Jennifer	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	6	\$36,223	Ecosystem Studies & Forecasting	NMFS	Rooper
West	Michael	Alaska Earthquake Information Center (AEIC) seismic station operations and maintenance (CRESTnet)	7	\$187,488	Coastal Hazards	NWS	Angove
Heinrichs	Thomas	High latitude proving groundImproving forecasts and warnings by leveraging GOES-R investment to deliver and test NPP/JPSS data in support of operational forecasters	8	\$112,500	Climate Change & Variabiity	NESDIS	Guch
Webley	Peter	Validation of GOES-R volcanic ash products: near real-time operational decision support/hazard analysis	9	\$159,523	Coastal Hazards	NESDIS	Guch
Hopcroft	Russell	RUSALCA data management	10	\$119,994	Ecosystem Studies & Forecasting	OAR	Crane
Walker	Gregory	UAS survery of marine debris generated by 2011 Japanese tsunami	11	\$129,165	Coastal Hazards	OAR	Hill
		RUSALCA 2013: Global change in the Arctic; fish ecology & oceanography; and Arctic food web structures (deobligated from NA08OAR4320870)	12	\$244,315	Ecosystem Studies & Forecasting	OAR	
		Total projects funded (including CI administration)		\$1,470,029			

Category	Number	unknown or none	B.A./B.S.	M.A./M.S. or M.B.A.	Ph.D
Research Scientist	9			2	7
Visiting Scientist					
Postdoctoral Fellow					
Research Support Staff	11		6	4	1
Administrative					
Total (≥ 50% NOAA Support)	0				
Total	20	0	6	6	8
Employees (< 50% NOAA Support)	20				
Located in NOAA Lab	0				
Obtained NOAA employment within last year	0				
Undergraduate Students					
Graduate Students	2			1	1
Total Students	2			1	1

Appendix 2. Summary of CIFAR-funded Personnel and their Terminal Degree (or degree seeking for students)

Appendix 3. Index of Principal Investigators (key words are in parentheses in cases where one PI has multiple project reports)

Heinrichs, T	12
Hopcroft, R. (data mgmt.)	10
Hopcroft, R. (RUSALCA zooplankton)	2
Iken, K	3
Norcross, B	7
Reynolds, J.	11
Walker, G.	18
Webley, P.	20
West, M.	22
Whitledge, T	9
-	