

U.S. Naval Academy Polar Science and Technology (USNA-PS&T) Program

Joseph P. Smith
Oceanography Department
U. S. Naval Academy
572C Holloway Road, 9D
Annapolis, MD 21402-1363
phone: (410) 293-6568 fax: (410) 293-2137 email: jpsmith@usna.edu

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<http://www.usna.edu/Oceanography/index.php>

LONG-TERM GOALS

In Fiscal Year (FY) 2015, through support from the Office of Naval Research Code 32 (ONR 32) Arctic & Global Prediction Program, the Oceanography Department at the U.S. Naval Academy (USNA) (re-)established a multi-disciplinary, undergraduate, field research-based Polar Science and Technology (S&T) program (USNA-PS&TP) based on the highly-successful USNA Polar Science Program (USNA-PSP) that existed from FY 2011-14. The expanded goals of the new USNA-PS&TP are to:

- 1) Develop faculty-led undergraduate Midshipmen research and engineering Capstone projects targeted towards specific S&T objectives/needs of the U.S. Navy.
- 2) Enhance course development and materials for Midshipman education in Polar Science.
- 3) Provide a faculty and Midshipman S&T work force with experience in conducting research in Polar environments for collaboration and partnership with the Naval Research Enterprise (NRE) and the greater Polar S&T community on field-oriented S&T projects.

Additionally, USNA-PS&TP is intended to serve as a resource for the ONR Code 32 Arctic & Global Prediction Program to contribute to U.S. Navy STEM (Science, Technology, Engineering, & Mathematics) education goals. And, given the unique nature of USNA Midshipmen, USNA-PS&TP will not only enhance the education of the next generation of scientists and engineers specializing in Polar Science, but also enhance operational understanding of the next generation of future Naval Officers who may have to operate in the Arctic region in the future.

OBJECTIVES

The specific objectives of the USNA-PS&TP in FY 2015 were to execute two collaborative Polar S&T efforts that demonstrate its ability to meet its stated goals and demonstrate the value of USNA-PS&TP as a collaborative S&T partner and a resource for ONR32-supported Principle Investigators (PIs), the NRE, and the greater Polar S&T community.

APPROACH

The two collaborative Polar S&T efforts were chosen in FY 2015:

- (1) USNA-PS&TP participation (4 Midshipmen and 1 USNA faculty) in the ONR-sponsored, Determining the Impact of Sea Ice Thickness on the Arctic's Naturally Changing Environment (DISTANCE) project led by the Marine Geosciences Division at the U.S. Naval Research Laboratory (NRL 7420), Washington, DC (J. Gardner, J. Brozena, A. Abelev, I. Rigor, and others; http://mp-www.nrl.navy.mil/marine_physics_branch/arctic.htm). The objective of the NRL DISTANCE project is to understand the changing Arctic environment, characterized by reduced ice volume, using new techniques for deriving accurate multi-sensor snow and ice thickness information and coupled ice-ocean models to explore the new Arctic dynamics.
- (2) USNA-PS&TP collaboration (1 Midshipman and 1 USNA faculty) with the Ocean Turbulence Group, Department of Oceanography at the Naval Postgraduate School (NPS) in Monterey, CA (T. Stanton, S. Gallaher, J. Stockel) on the ONR 32 Emerging Dynamics of the Marginal Ice Zone (MIZ) Departmental Research Initiative (DRI).

In the USNA-PS&TP model, research collaborators are paired with a USNA research coordinator who prepares a tailored, interdisciplinary team of USNA PS&TP faculty and Midshipmen to best meet the specific research needs of the collaborative team. The USNA research coordinator can leverage existing USNA courses, equipment, materials, collaborations, and programs to prepare Midshipmen and participants pre-effort, enable USNA PS&TP preparation in specific efforts, and then follow-through, post-effort, to provide specific, tangible research and S&T products to collaborators and their sponsors.

WORK COMPLETED



Figure 1. The USNA-PS&TP Team working with the NRL-DISTANCE research team and their collaborators field during the field research campaign in Barrow, AK in March, 2015.

The USNA-PS&TP demonstrated its ability to meet its stated goals primarily through two activities in FY 2015. In March of 2015, a USNA PS&TP team (4 USNA Midshipmen and 1 USNA faculty) joined the ONR-sponsored NRL-DISTANCE research team and their collaborators in a field campaign in Barrow, AK (**Fig. 1**). During the field research campaign, USNA-PS&TP participants lead and/or assist in:

1. Laying out precise sampling grids in two sea ice locations.
2. Obtaining snow thickness measurements using a magnaprobe sampling device.
3. Obtaining ice thickness measurements using a gas-powered auger.
4. Collect density and salinity measurements of ice and snow samples.

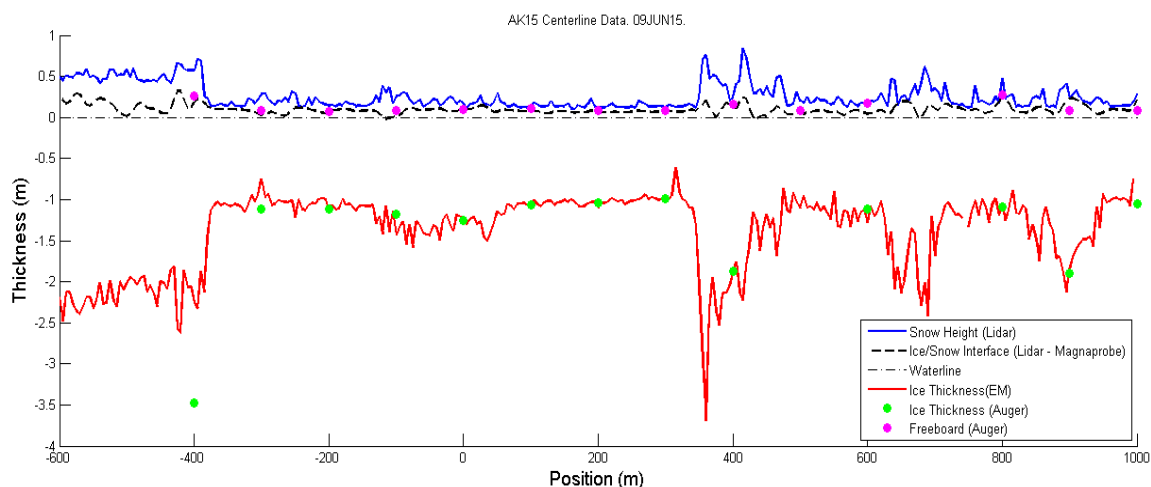


Figure 2. 1600 m centerline with field ground-truthing measurements (EM, magnaprobe, auger) and remotely sensed data (LIDAR).

Two of the USNA-PS&TP Midshipmen who participated in this field research also participated in a 4-week, follow-on Internship with NRL7420, Washington, DC in the summer of 2015 to analyze data collected during the field campaign. During the internship, USNA-PS&TP Midshipmen worked with NRL7420 scientists to compare remotely-sensed data (LIDAR, SAR) to field ground-truthing measurements (**Fig.2**). The results from this internship will form the basis of an NRL Technical Memorandum Report (*in preparation*).

One additional USNA Midshipman from the USNA PS&TP conducted a 4-week Summer Internship with the Ocean Turbulence Group, NPS, Monterey, CA working with researchers (T. Stanton, S. Gallaher, J. Stockel) processing and analyzing upper ocean data collected as part of the ONR 32 MIZ DRI field campaign conducted during the summer of 2014 in the Beaufort Sea. The NPS Ocean Turbulence Group observation dataset is comprised of Acoustic Doppler Current Profiler (ADCP), high resolution thermistors, inductive conductivity cells, 3-D acoustic current meters (ACM), 3-D acoustic anemometer (atmosphere), solar radiometers, and mixed layer CTD measurements. Additionally, a large volume of commercial (SAR) and NTM (Visible) imagery were collected in support of this project and were processed by the USNA PS&TP Midshipman intern in an effort to establish an automated algorithm using thresholding techniques to partition image pixels into open

water, melt ponds, and sea ice in order to better estimate radiative absorption into the upper ocean. The USNA PS&TP Midshipman intern also processed and analyzed archived (pre-MIZEX) upper ocean and satellite data. The objective of the ONR MIZ program was to measure and understand the complex interactions and feedbacks in the expanding Arctic MIZ and incorporate these processes or sub-grid parameterizations of these processes into coupled ice-ocean models in order to predict the future state of the MIZ. The research performed by the USNA PS&TP Midshipman during this internship will serve as the basis of her ongoing Honors Independent Research thesis work (Advisor: J.P. Smith) that will be completed in the Spring of 2016.

Both of these internships were coordinated under the USNA Summer Internship Program (<http://www.usna.edu/AcResearch/Summer%20Internships/>).

RESULTS

The ONR 32-sponsored USNA PS&TP activities in FY 2015 show that the program can execute efforts that meet its stated goals and demonstrate the value of USNA-PS&TP as a collaborative Polar S&T partner and a resource for ONR32-supported PIs, the NRE, and the greater Polar S&T community. Lessons learned from the FY 2015 effort are:

1. The USNA PS&TP is a cost-effective STEM work force with experience in conducting research in and on Polar environments.
 - The USNA PS&TP has an established record of working in Polar environments and collaborating in Polar S&T efforts since 2011.
 - USNA PS&TP Midshipmen are well-disciplined, motivated, STEM undergraduates and future Navy and Marine Corps officers.
 - Costs associated with USNA PS&TP Midshipman participation in Polar S&T efforts are limited to, at a maximum, travel, lodging, and per diem costs. These costs can be further minimized by shared lodging, use of government facilities, and leveraging of internal USNA resources.
 - Costs for USNA PS&TP faculty participation is limited to a maximum of 2 months summer salary plus travel, lodging, and per diem costs for USNA civilian faculty and travel, lodging, and per diem costs for USNA military faculty.
 - When possible, USNA PS&TP will bring existing equipment, materials, and additional funding to collaborative Polar S&T efforts. When not possible, if these are required, then there may be additional costs to collaborative partners for USNA PS&TP participation in Polar S&T efforts.
2. USNA PS&TP is best suited for participation in collaborative Polar S&T efforts planned well-in advance that take place during a two-week holiday break in December, a 10 day Spring Break period in March, or in one of 3 four week training blocks from May to August.
 - Collaboration with USNA PS&TP is best started > 6 months before the planned Polar S&T effort.
 - The USNA PS&TP does not have the capacity or administrative means to respond to support or collaboration requests < 30 days in advance.

- The USNA PS&TP can potentially support limited efforts (< 1 week; 1-2 participants) during the Academic Year (mid-August through late May) but participation requires advanced notification (> 30 days) and is subject to, on a case-by-case basis, additional review and approval by the academic and military leadership at USNA.
 - USNA PS&TP participation in Polar S&T efforts during the (Northern Hemisphere) summer (May-August) allows for additional coordination under the USNA Summer Internship Program (<http://www.usna.edu/AcResearch/Summer%20Internships/>). Planning for Summer Internships starts in October to November of the year prior to the Polar S&T effort.
 - The value of PS&TP participation in Polar S&T efforts can be extended during the USNA Academic Year by remote participation through Special Topics Courses, Readings Courses, and Independent Research and Capstone Engineering Projects.
 - Collaboration with International Polar S&T partners is possible and, in some cases, can leverage internal USNA Programs through the USNA International Programs Office. Such coordination requires additional administration and planning and coordination should begin, when possible, > 12 months prior to the planned effort.
3. As an interdisciplinary program, USNA PS&TP can tailor its support team to include Midshipman and faculty from any of the STEM or Humanities and Social Science Departments at USNA (<http://www.usna.edu/Academics/Majors-and-Courses/Divisions-Departments.php>).
 - The USNA-PS&TP Team will work closely with their collaborators and ONR 32 to ensure that support is aligned with the S&T needs and objectives of collaborators and sponsors.
 4. The USNA PS&TP Program can serve as a collaborative vehicle to connect ONR 32 and its sponsored PIs to other Polar S&T programs such as the National Aeronautics and Space Administration (NASA) IceBridge Program and the National Science Foundation Division of Polar Programs.

IMPACT/APPLICATIONS

The successful ONR 32 sponsored efforts in FY 2015 are examples that demonstrate the value of USNA-PS&TP as a collaborative partner and a resource for the NRE and the greater Polar S&T community. These events also show how USNA PS&TP might be leveraged by ONR 32, its sponsored researchers, and its S&T partners to add value to their research efforts to better address the S&T needs and objectives of the U.S. Navy in Polar environments. The USNA-PS&TP will help develop the next generation of scientists and engineers specializing in Polar Science and enhance operational understanding of future Naval Officers who may have to operate in the Arctic region in the future. The USNA PS&TP will request support from ONR 32 in FY 2016 to continue and build upon successes in FY 2015.