Polar Science Program

Aerospace Engineering Capstone

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Dr. Todd Valentic, SRI
Mr. Dan Rhodes
MIDN 1/C Charles Newnam
MIDN 1/C Morgan Oblinsky

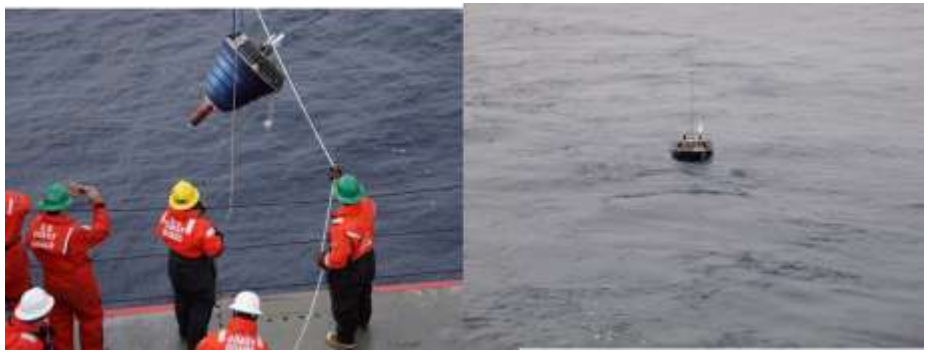
USNA Polar Science Program

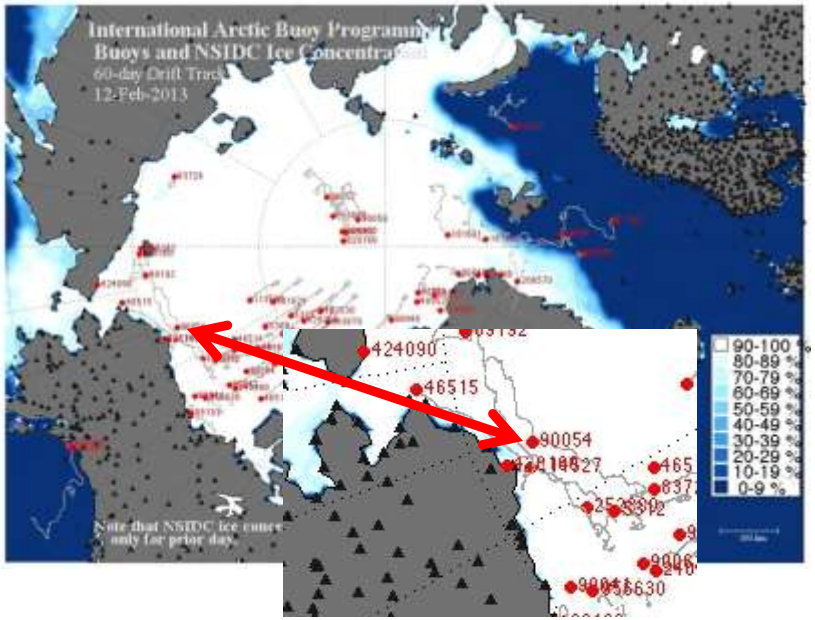
Understanding the rapidly changing Polar environment is of growing interest to both the scientific research community and the United States Navy. The U.S. Naval Academy's Oceanography Department has developed a project based ***Polar Science Program*** ***(PSP****), enhancing Midshipmen education and research, in addition to introducing future Naval Officers to the harsh Arctic environment.*

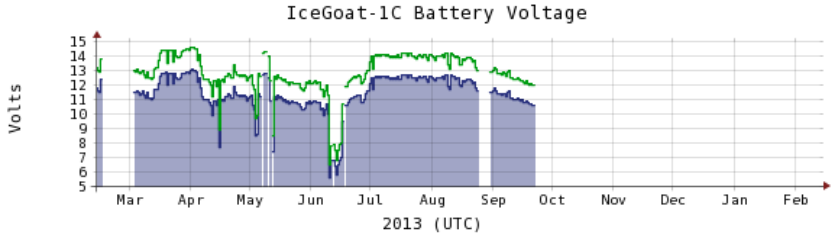
Interdisciplinary capstone projects within the PSP leverage expertise from both the Engineering and Science Divisions at USNA. STEM Education and Outreach significantly enhances the broader impacts of this program.

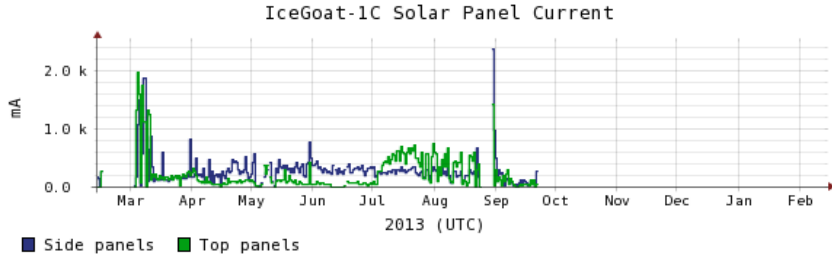
IceGoat1

- Still reporting via Li-ion
  - GPS (ice motion), AirTemp, IceTemp, SLP
  - IABP
- Solar Array (webcam/Iridium System) not reporting
  - Possible damage during deployment drop on *USCGC Healy*
- 6+ Months of Webcam Data Collected









3/31/2013
2012
2013
N
Beaufort Sea
Image U.S. Geological Survey
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Image IBCAO
Google earth

PSP Team

TEAM	Department	Task
LCDR Woods	Oceanography	Team Lead
CDR Bruninga	Sat Lab	Power Design Lead
Dan Rhodes	USNA Hydro Lab	Construction/Tech Advisor
Dr. Todd Valentic	SRI Intl	Computer Eng Advisor
1/C Newnam, Oblinsky	Astro Capstone	Power Control and Integration
1/C Broniatowska, Paruso, Lange	Oceanography Capstone	Data Analysis and Interpretation
1/C Reynolds, Solmonson, 2/C Bong	Ocean Engineering Capstone	Future USNA Buoy Design
2/C Nowak	Comp Sci Research	SBC Programing
2/C Calmus	Systems Engineering Research	Arctic ROV Development

EA 470 Course Objectives

- Preliminary design of a spacecraft to include:
  - preliminary layout
  - specifications of on-board systems
  - power subsystem requirements and design

Aero PSP Mission Objectives

- The mission of the Aerospace Engineering portion of the Polar Science Program is to supplement Arctic and Antarctic environmental data observing systems. This requires not only the use of solar power but also the budgeting of that power to successful levels to sustain operational capabilities for the duration of the exercise.

USNA Polar Science Program (PSP)

Overview

- Joint Arctic Research project to design, build and deploy Polar Observation Platforms
- Progress to date
  - IceKid 1- Deployed Fall 2012
  - NAICEX: Barrow, Alaska
    - IceKid 2A – Hydrophone & Camera
    - IceKid 3T- Weather station & Camera

IceKid 1

IceKid 3T

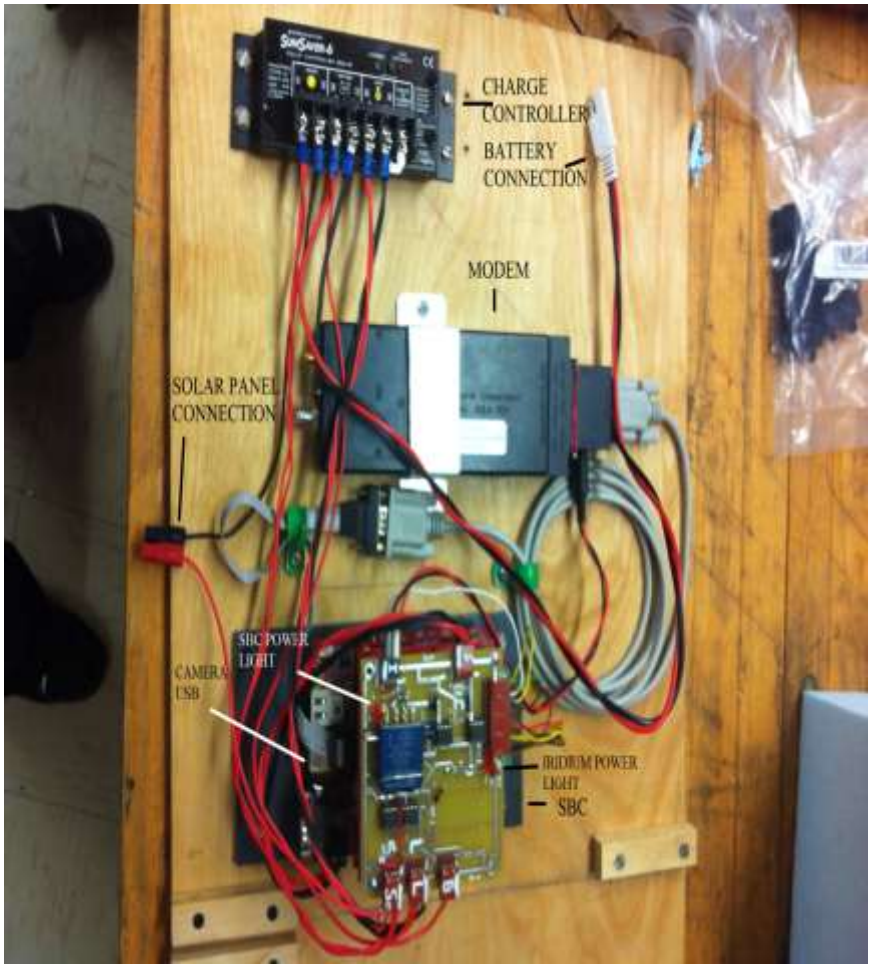
IceKid 2A

IceKid

- Arctic / Antarctic Autonomous Observation Platform
- Near Real Time Data!
- Engineering standpoint:
  - Design, Build, “Launch”

Inside IceKid

- Iridium Modem
  - NAL A3LA-XGS
  - NAL A3LA-RS
  - Beam RST600
- Charge Controller
  - Morningstar SS-10
- Single Board Computer
  - TS-7260



IceKid Build

IceKid-1

- Dartmouth College
  - Deployed for 26 days near McMurdo Station in Antarctica.
  - Collected over 3000 web cam images
  - Instrumental monitoring platform for the success of a Dartmouth snow chemistry study.
- NPS Research
  - Redeployed from Dec-Feb 2013 to Pine Island Ice Shelf
  - Collected 4000 web cam images
  - Eventually Failed on Site due to modem failure
  - No Recovery Efforts until Next Season

IceKid-1 Time Lapse

IceKid – 1 Failure

- IceKid-1 last transmission: 29Jan2013.
- Root of the issue:
  - NAL A3LA-XGS Iridium Modem used in IceKid – 1.
    - GPS modem with a Microcontroller.

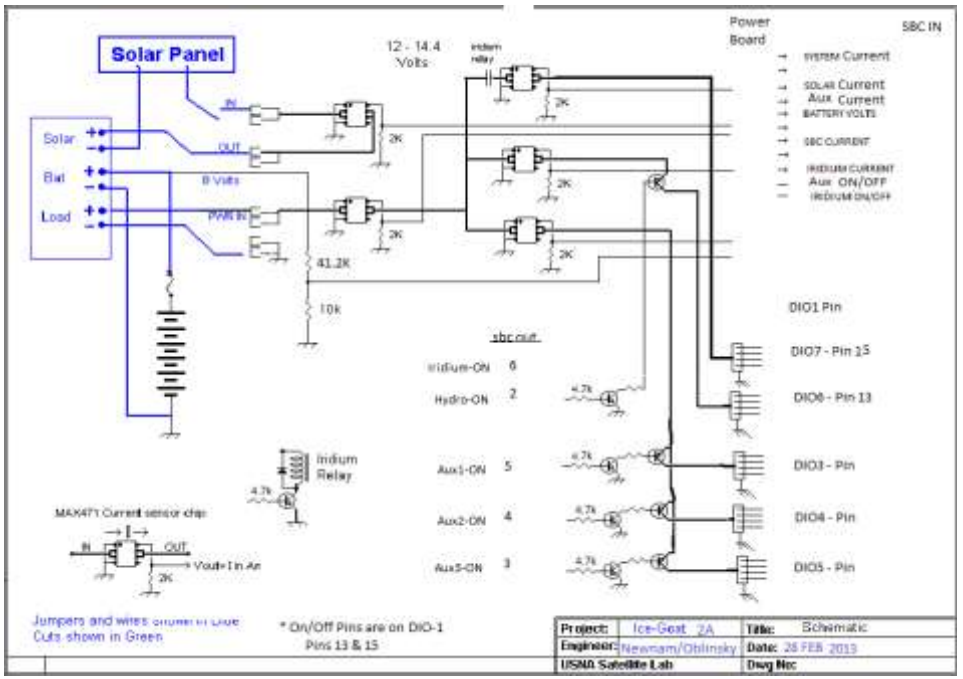
- Lesson Learned:
  - Do not use XGS version as a modem!
  - IceKid - 2A/3T Built with A3LA-RS Modems and Beam RST600 modems

IK2/3 Iridium Modems

- Beam DataMODEM RST600
- Input Voltage: 4-32 VDC
- Consumption at 5 VDC:
  - Input standby current – 250 mA
  - Max current during call – 2.5 A
  - Typical current during call – 800 mA

Power Board

- Power Board Redesigned from IK1 to IK2/3
- Believed to be source of present issues
- Issues with MAX 471 chips



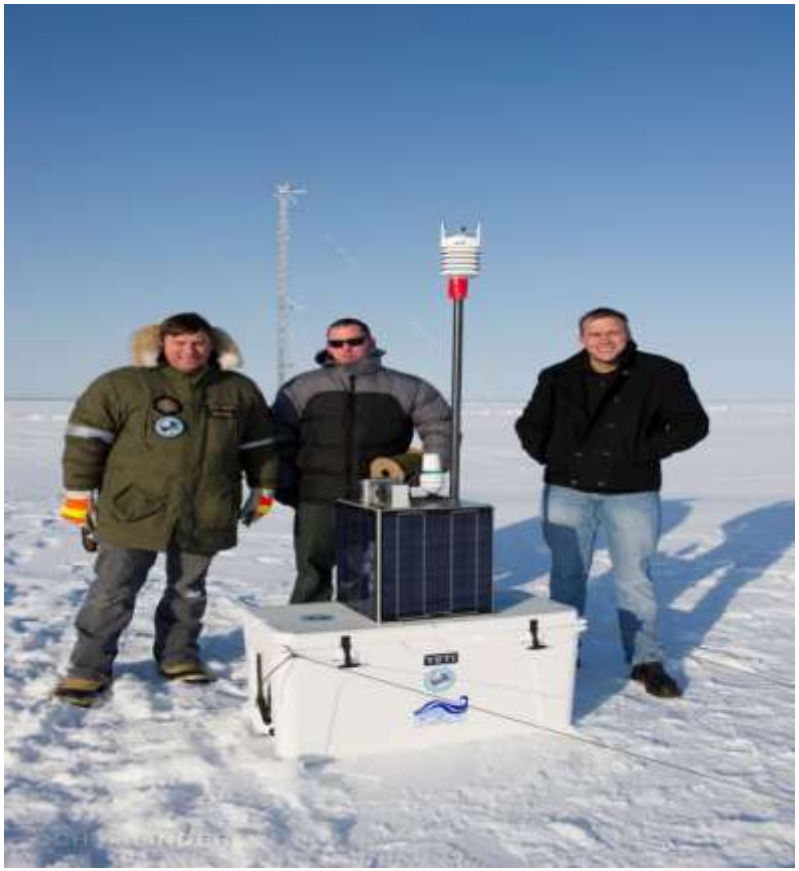
New Solar Design

Spec	IceKid – 1	IceKid – 2A
# of Panels	1	4
Coverage	120º	360º
Model	SC24-12V	SC18-12V
Current	1.24 A	0.93 A
Dimensions	13”X21”	13”X16”
Power	24 W	18 W

•Solar Panel change due to uncertainty of IceKid orientation after deployed on floating sea-ice

IceKid 2A & 3T

- IceKid 2A – Hydrophone
- IceKid 3T – Weather Station



IceKid 2A - Hydrophone

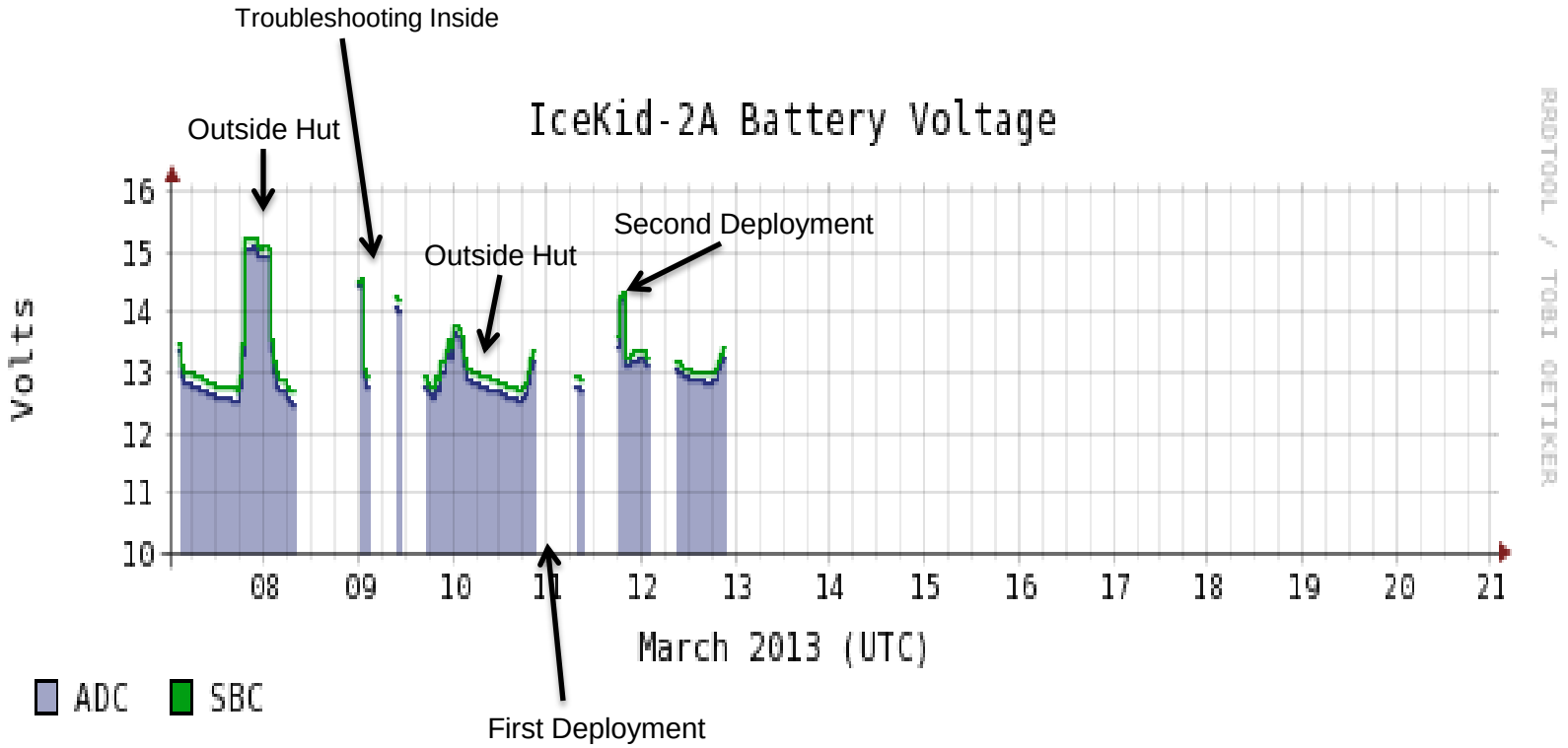
Sparton model PHOD-1

Usable Frequency Range	10 Hz to 50 kHz
Resonance Frequency	46 kHz
Receive Sensitivity	-156 dB re 1V/µPa
Horizontal Directivity	Omni +/- 1 dB to 40 kHz
Vertical Directivity	Omni +/- 1 dB to 20 kHz
	Omni +/- 3 dB to 40 kHz
Max Operating Depth	Tested to 300 m
Operating Temperature Range	-2°C to +55°C
Storage Temperature Range	-40°C to +125°C
Supply Voltage	12V to 30V DC
Current Draw	10 mA
Preamplifier Gain	37 dB
Preamp Calibration Feature	Built in circuitry
Mechanical Dimensions	31.75 mm OD x 118.11 mm Length

IceKid 3T - Vaisala Wx Station

- WXT520 Weather Transmitter
- Measures barometric pressure, precipitation, temperature, and and direction.
- Input voltage: 5…32 VDC
- Typical Power Consumption: 3mA @ 12VDC

Troubleshooting IceKid-2A



IceKid2A Acoustic Capability

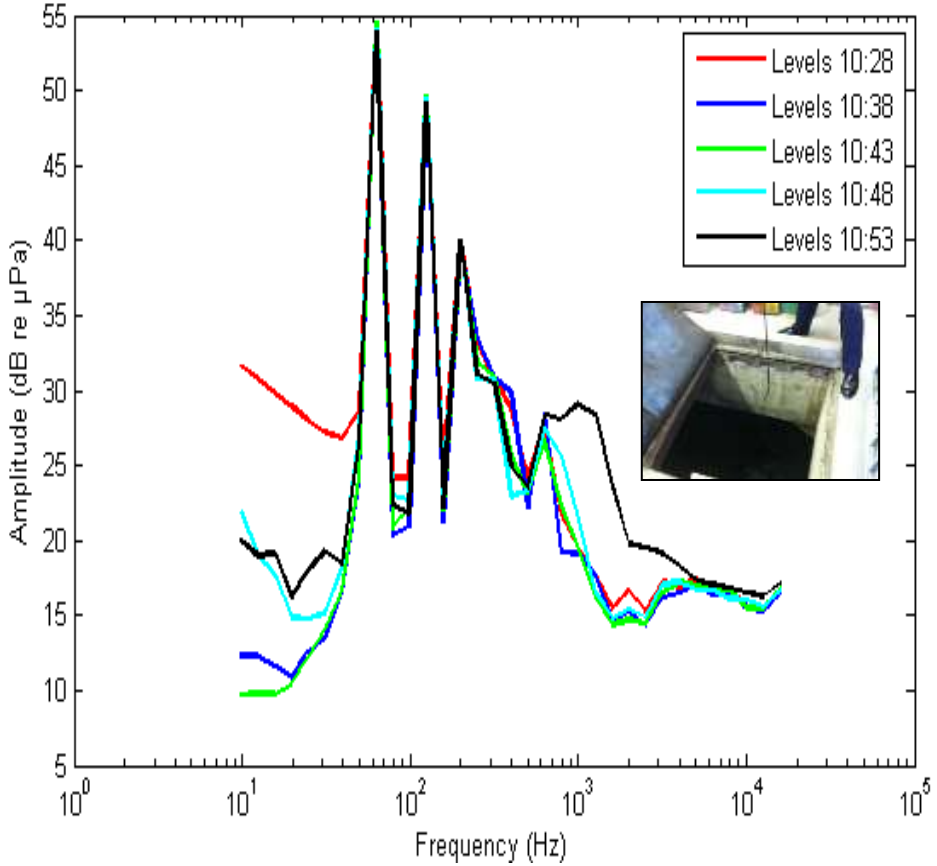
- Acknowledgments:
  - LCDR John Woods - USNA, Dr. Todd Valentic - SRI, Dr. Stephen Means - Dr. Stephen Wales, Naval Research Laboratory, D.C., Ensigns Nicolas Schmitt and Jonathan Zakoian - French Naval Academy, Midn Brad Schieve, Will Parker and Haley Nowak

- Designed to:
  - Capture one minute of acoustic data sampled at 40 kHz every 15 minutes
  - Calculate spectral averaged ambient noise levels within 1/3 Octave bands
  - Transmit 4 x 33 discrete values via iridium modem hourly

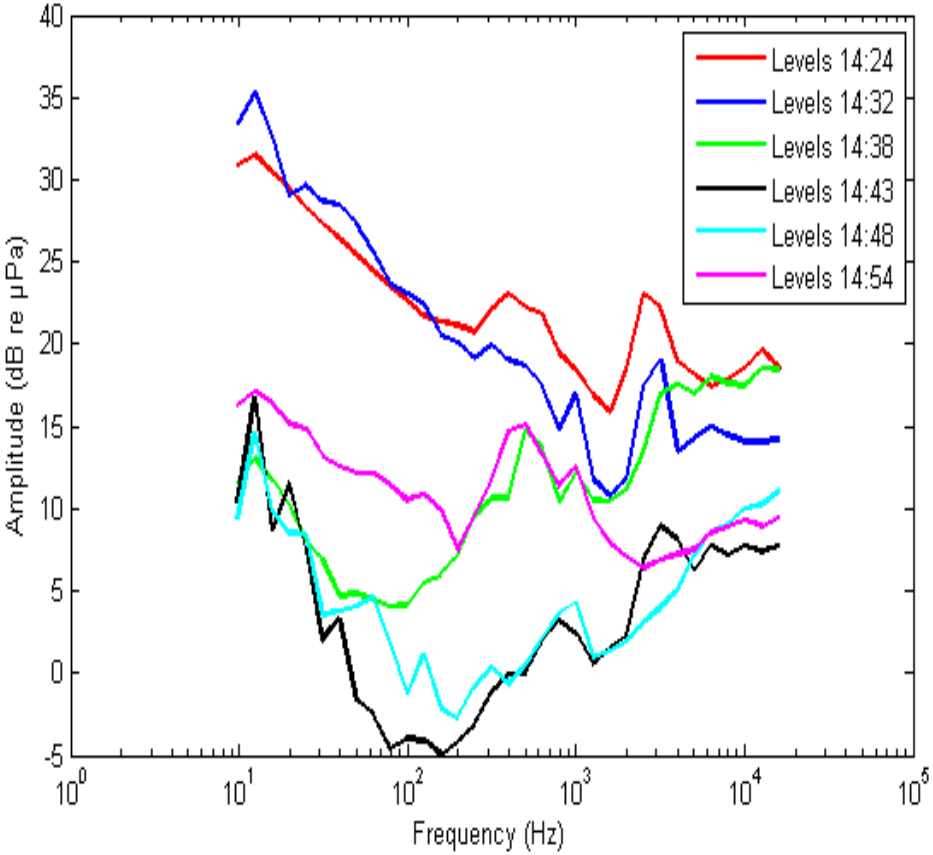
- Operational tests:
  - Oct 24 / Hendrix Lab & Severn River (non-automated)
  - Nov 7 / Severn River (automated)
  - Mar 1 / Severn River (automated / satellite)
  - Mar 5 & 9 / Barrow (automated / satellite)

October 24 Test (non-automated)

Hendrix lab

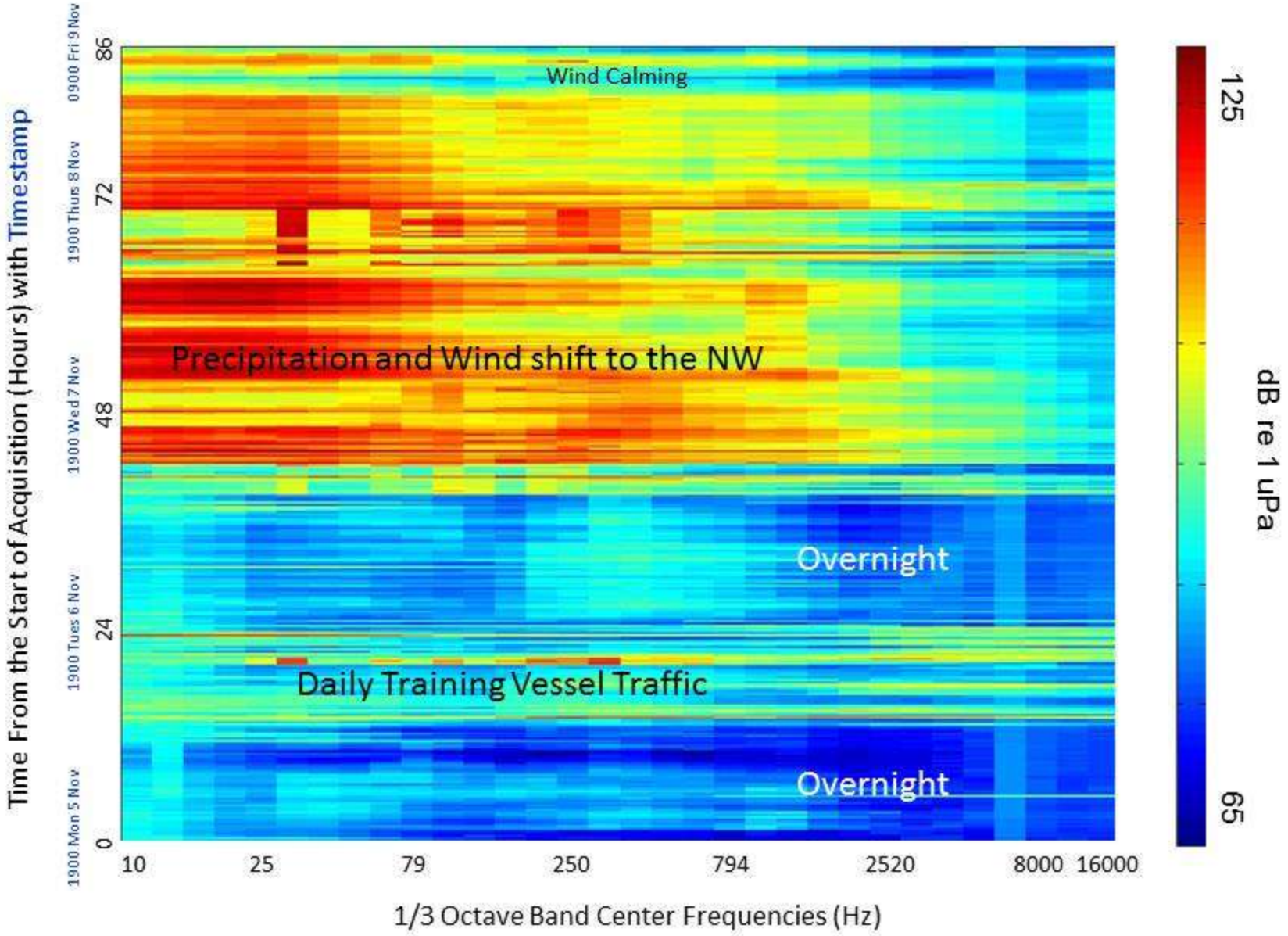


Pier side Severn River

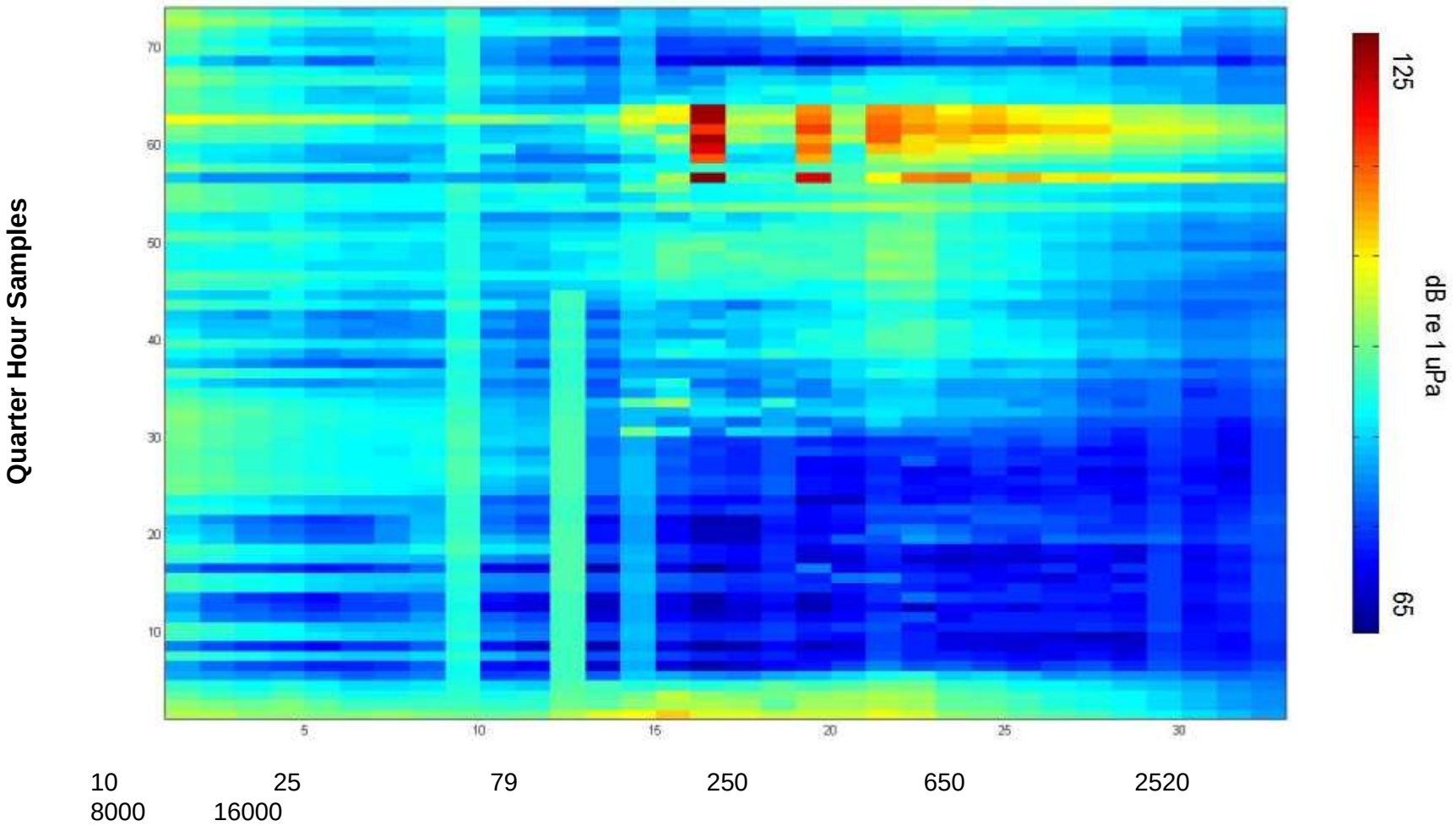


Images Source: "IceGoat 2a: Programming an autonomous device to monitor Arctic ambient n

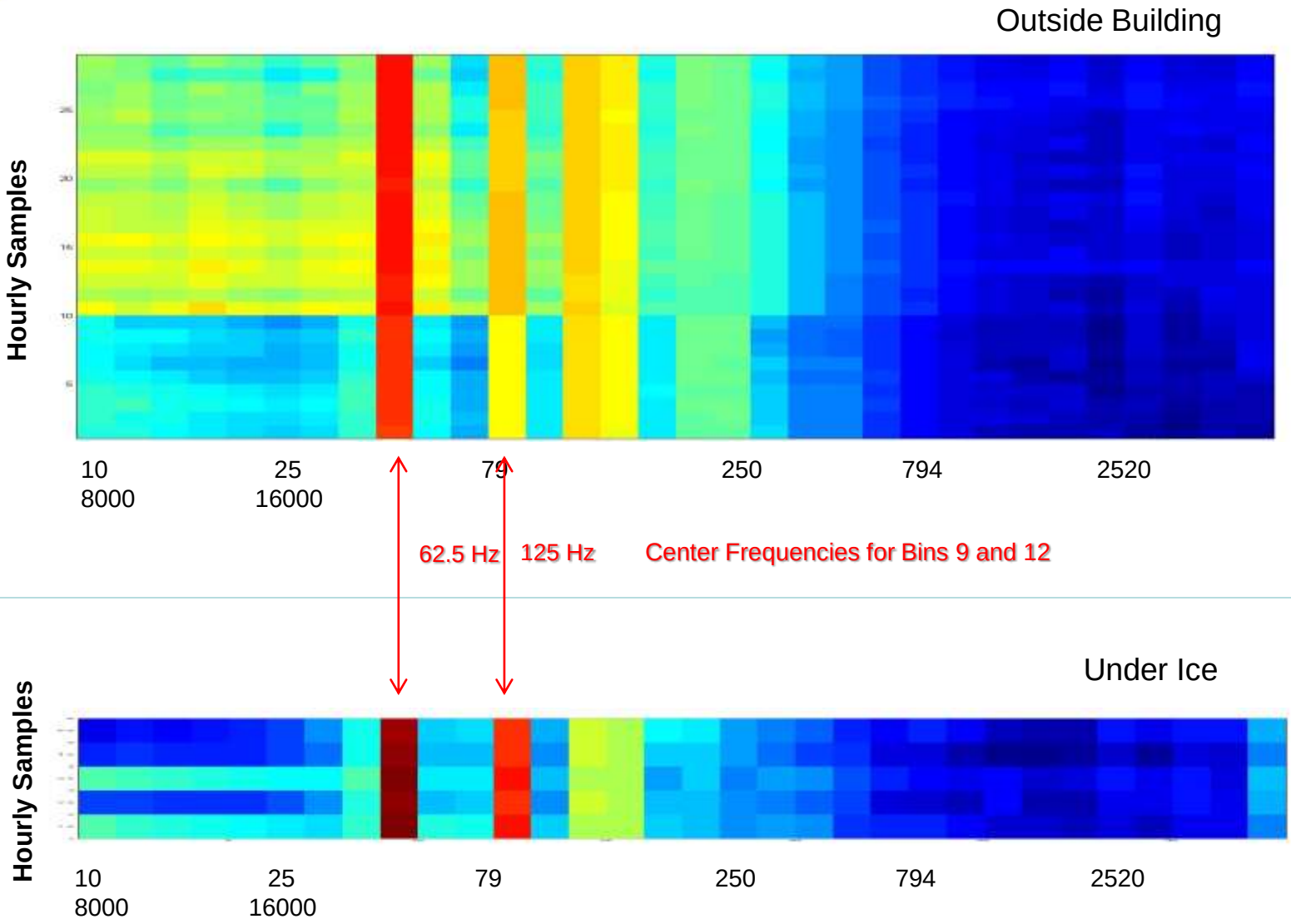
Automated Data Acquisition Test for ICEGOAT 2A – Pierside Severn River



Pre-Barrow Severn River Test (1 March)



Barrow Data - Troubleshooting



The Problem?
(maybe)

Barrow Utilities & Electric Co.-Op., Inc.

Image source: Barrow Utilities & Electric Co.-Op. Website

Questions?

Welcome to Barrow
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America's Northernmost Ci
Alaska
Barrow
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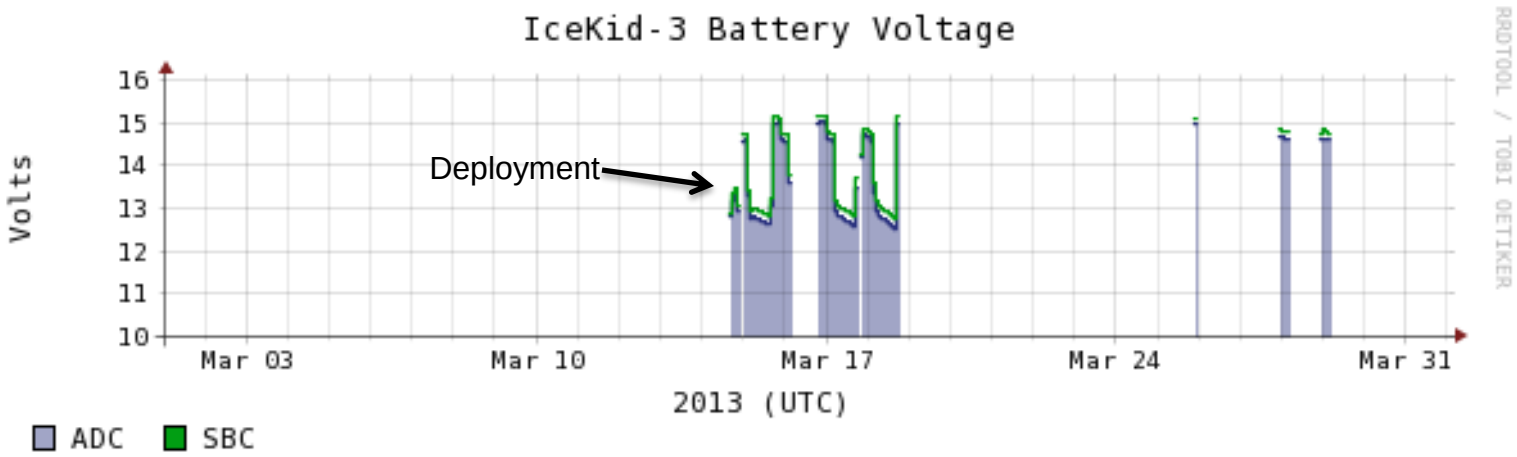
Troubleshooting IceKid

- IceKid 2A and 3T still having issues.
- Exact problems yet to be determined

Troubleshooting IceKid-3T