Shelf Fleet and Oceanographic Update

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Outline

• Review of Oceanographic Conditions in 2019
• Broader View- Rings and Warming
• Upcoming Experiment- NSF Salinity Intrusion, May/June 2020
• Upcoming Proposals
• Outer Space!
Project Goals: study the oceanographic conditions across the continental shelf off the coast of RI

Fishing Vessels collect temperature, salinity versus depth in six designated study zones

Each F/V samples 2 stations every other week

Currently funded through June 2021

Huge thank you to our fleet participants!

– Brooke C, Erica Knight, Excalibur, Harvest Moon, and Mister G
Progress to Date

617 profiles as of Jan. 8, 2020 (HOORAY!!!!)

3 Peer-Reviewed Science Publications (Latest in Dec. 2019)

3 National Science Foundation Proposals submitted relating to Shelf Fleet data, 1 funded

Numerous media interactions, latest USA Today cover article and Yahoo Finance On the Move interviews (Aubrey and Bob C.)

GG Participation in Illex workshop in Wakefield RI November 2019
Temperature Data by month and box

CFRFWHOI monthly box averages, temperature [deg F]

Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6

Box #

2015  2016  2017  2018  2019

Time
Salinity Data by month and box

CFRFWHOI monthly box averages, salinity [psu]
Sea Surface Temperature- A Tale of Two Different Half-Years

Winter and Spring 2019
Generally cool over the Continental shelf, slightly Warm over continental Slope

Summer and Fall 2019
Very warm over Continental shelf and Slope except for Georges Bank and Nantucket Shoals

Color bar Goes from +9°F to -9°F

Courtesy Kim Hyde NEFSC
Profiles 2015-2019 April November Zone 2

April Temperature
- 2015
- 2016
- 2017
- 2018
- 2019

April Salinity
- 2015
- 2016
- 2017
- 2018
- 2019

November Temperature
- 2015
- 2016
- 2017
- 2018
- 2019

November Salinity
- 2015
- 2016
- 2017
- 2018
- 2019

April Temperature
- 48° Surface 2019
- 42° Bottom 2019

November Temperature
- 58° Surface 2019
- 63° Bottom 2019

April Salinity
- 31.4 Surface 2019
- 32.4 Bottom 2019

November Salinity
- 32.5 2019
- >34 PSU 2019
Profiles 2015-2019 April November Zone 4

**April Temperature**
- 2019: 44° Surface, 42° Bottom

**April Salinity**
- 2019: 32.4 Surface, 33.0 Bottom

**November Temperature**
- 2019: 62° Surface, 63° Bottom

**November Salinity**
- 2019: 34.1 Surface, 34.8 Bottom
Cross-Shelf Temperature 2019-2018

April 2019

April 2018

October 2019

October 2018
Cross-Shelf Salinity 2019-2018

April 2019

April 2018

October 2019

October 2018
What caused the warming in Summer and Fall?

Sea Surface Temperature
August 6, 2019

Temperature Anomaly First Week of August relative to 1982-2010 average

Maximum Anomaly- 3°C (5.4°F)
Very warm south of Georges Bank and In Massachusetts Bay (from Ke Chen)
R/V Armstrong Student Run Cruise
September 20-22, 2019

11 CTD Profiles out to 500 fathoms

SST
Sept. 21

R/V Neil Armstrong
Hurricane Dorian pushed thick layer of salty (>34 PSU) and Warm (>68°F) Water to the 15 fathom isobath
Only remnants of Shelf Water in thin patches near bottom
Velocity and Surface Flowthrough

Normally Here

34.0 PSU

Eastward Flow

Shelfbreak Jet
Inshore Bottom Temperature

Courtesy: Jay Swoboda

Sept 1  Oct 1  Nov 1  Dec 1

Average Daily Temp (F)
Long-Term Trend- Warm Core Rings

Regime Shift in 2000

18 per year 1980-1999
33 per year 2000-2017

Ring Formation by month in 2019
Big spike in July

Courtesy A. Gangopadhyay and A. Silver
Pioneer Array Inshore Mooring

Very salty in October
4 PSU change from August to October

Very warm in August consistent with NDBC Nantucket Shoals buoy
Spatial Pattern of Surface Warming
1982-2018

Two regions of fastest warming rate from satellite sea surface temperature: Continental slope south of Georges Bank and Gulf Stream near Cape Hatteras

From Chen et al. 2020
Marine Heatwave of 2017

Red Dots
January 2017

Humpback Whale Mortality
NSF Salinity Intrusion Experiment

Science Question- What are the Typical alongshelf scales for mid-depth salinity maximum Intrusions?

Have they been changing in terms of thickness, vertical position, maximum salinity?

Key Parameters- Delta S, Sm (max salinity), thickness, depth of intrusion (from Lentz, 2003)
Recent Observations (2017 and 2018)

Section South of Nantucket August 2017

August 9 2018
36 PSU
Near Martha’s Vineyard!
We need help!

- Communications with R/V Armstrong to initially find $S_{max}$ intrusion (hear about Shelf Fleet profiles leading up to experiment)
- Cruise will be on R/V Endeavor May 27-June 4
- We will be operating multiple Autonomous Underwater Vehicles - will notify fishing community several weeks before the cruise
- We will be making turbulence measurements for mixing and also acoustic backscatter
- CFRF will be preparing brochures about the experiment and the findings for wide distribution
Upcoming Proposals

• Spring- NSF Coastlines and People- Combine Shelf and Lobster/Jonah Crab collection and data analysis, include social science for effects of ocean warming on coastal communities

• NSF Gulf Stream Ring Formation- Data analysis and theory to determine how and why Warm and Cold Core Rings form (Avijit lead)

• NSF Storms and their impact at the Pioneer Array (GG lead, Al Plueddemann, Grad Student)
The View from Space - October 2020?

BeaverCube- MIT/WHOI CubeSat will have SST and Ocean Color over our study area
Summary

• In 2019 first half of the year was generally cool and fresh, second half was very warm and salty due to Warm Core Rings
• Temperatures south of Nantucket Shoals were even warmer than 2012 in August
• Very salty at the Pioneer Array in October, Gulf Stream level salinity
• NSF Salinity Intrusion project in late May/early June