Some Considerations of Impacts of Oceanographic Processes on Acoustic Propagation over the New England Shelf

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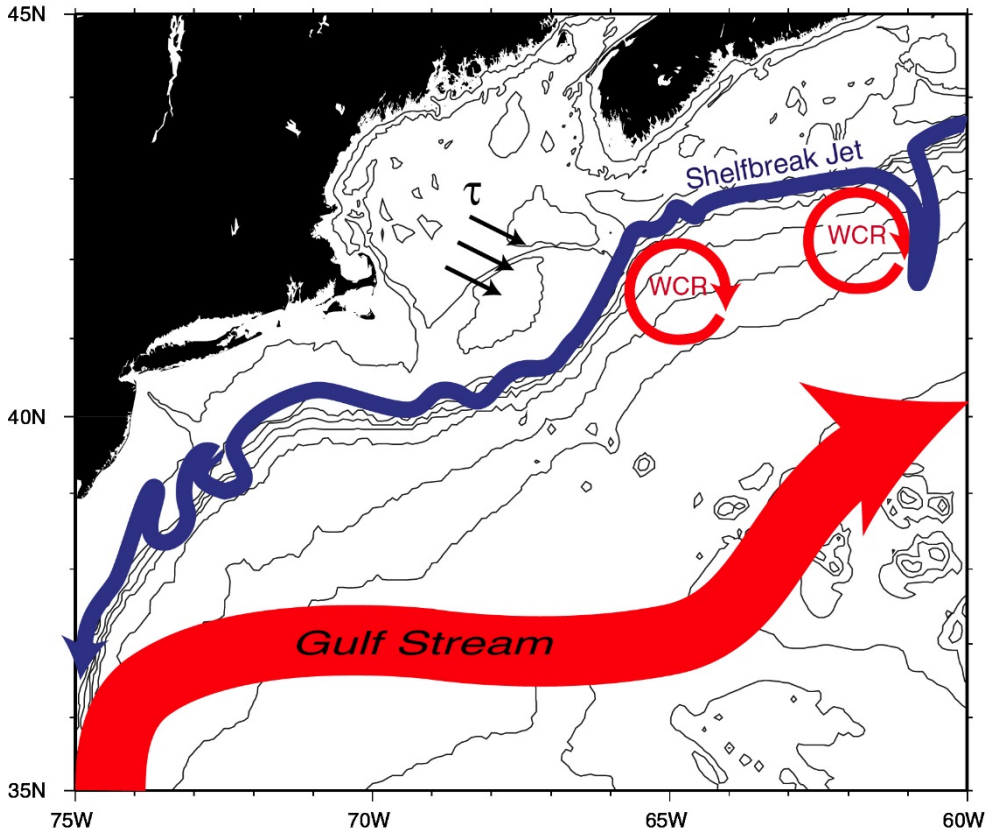
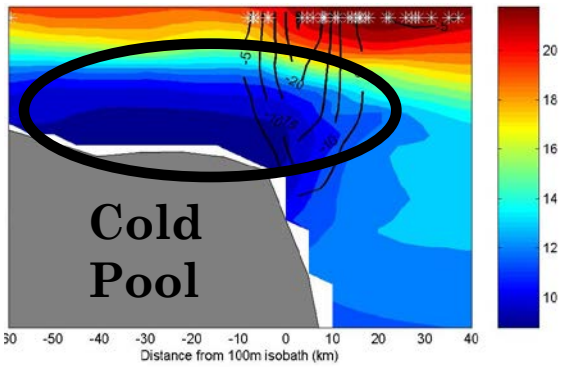
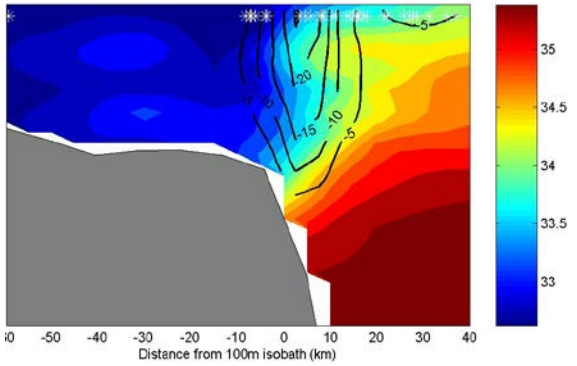
Overview

- Basic circulation and hydrographic structure
- Climatological fields and some synoptic examples
- Recent warming- the remarkable spring of 2012 in the Middle Atlantic Bight
- Spring 2014- Contrasting conditions and the impact of offshore forcing
- The OOI Pioneer Array: Science assets and preliminary science results
- Some options to consider for resolving sound speed fields and shelfbreak frontal structure and position

The Middle Atlantic Bight





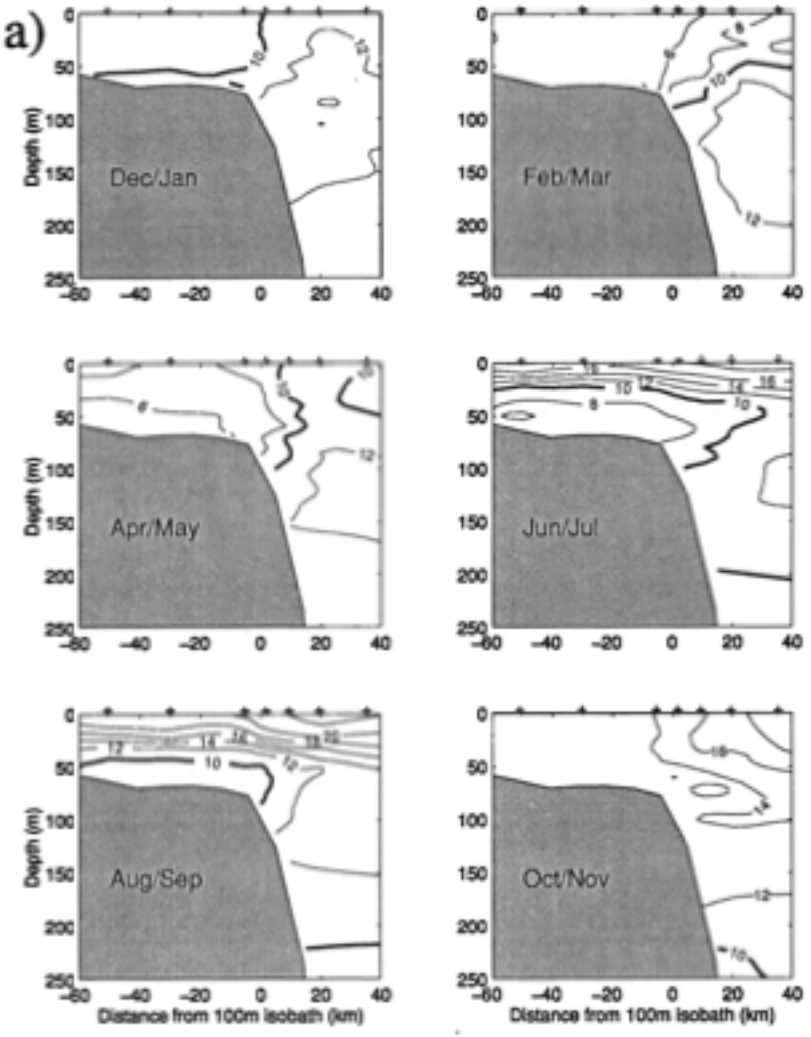


Seasonal Temperature Fields

Well mixed over continental Shelf in Dec/Jan and Feb/Mar

Strong thermocline in Jun/Jul and Aug/Sept

Temperature difference goes from 2° C to 6° C over the course of the seasons



Shelfbreak Jet Characteristics

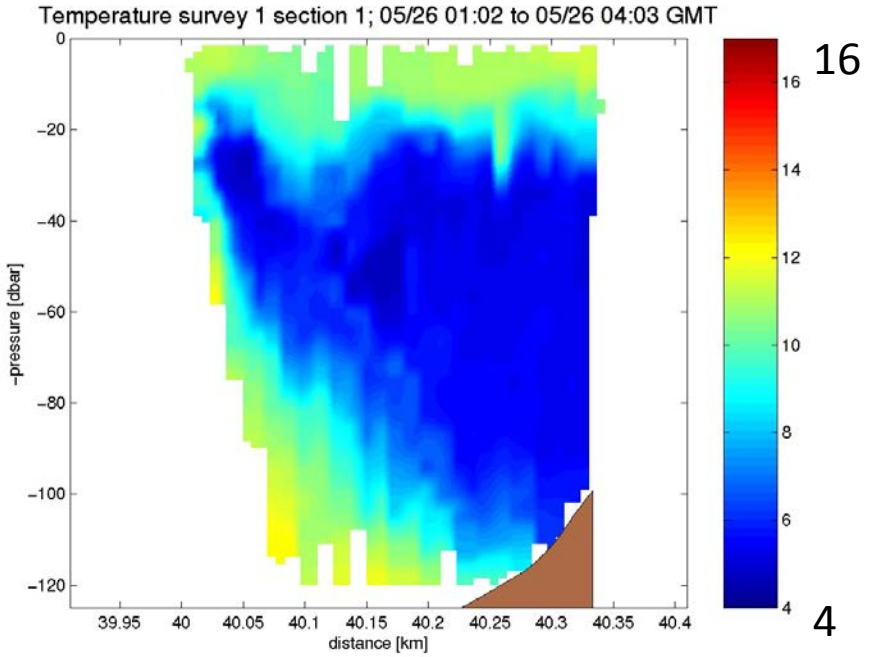
- Use thermal wind relation ($u_z=(g/\rho_0 f)(\delta\rho/\delta y)$) and mean bottom velocities from long-term mooring deployment to get mean geostrophic velocity
- Can calculate transport, relative vorticity $(\delta u/\delta y)/f$, cross-shelf position of jet

Table 2. Frontal Jet Characteristics (Annual Average)

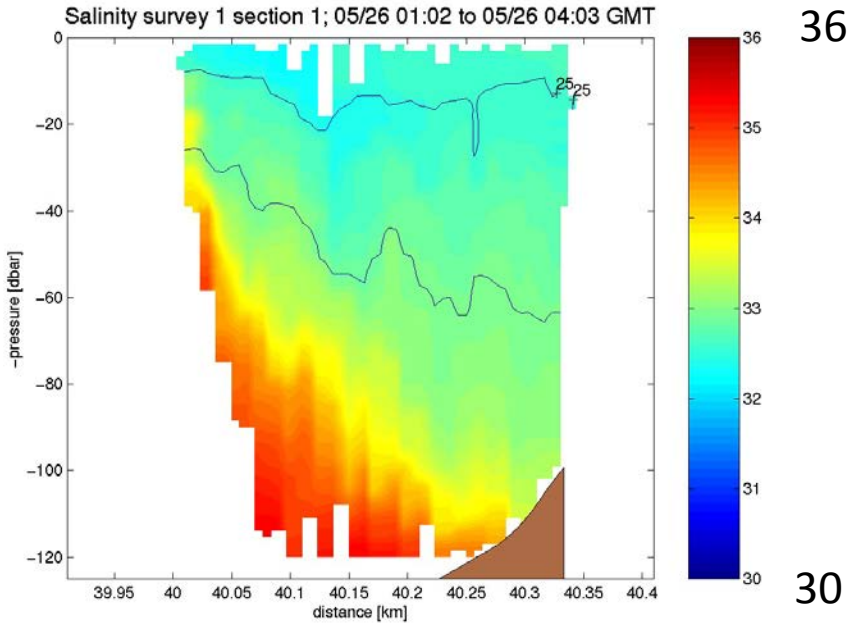
Region	Shelfbreak Depth m,	Foot of Front, m	Isobath With Maximum Jet Velocity, m	Vertical Scale of Jet, m	Jet Width, km	Jet Transport, Sv	Maximum Jet Velocity, m s^{-1}
Georges Bank	125	120	275	75	47	0.45	0.16
Nantucket Shoals	100	95	145	62	21	0.24	0.22
New Jersey	75	75	162	56	19	0.16	0.15

Typical Spring Synoptic Section NEST07 May 2007

Temperature May 26



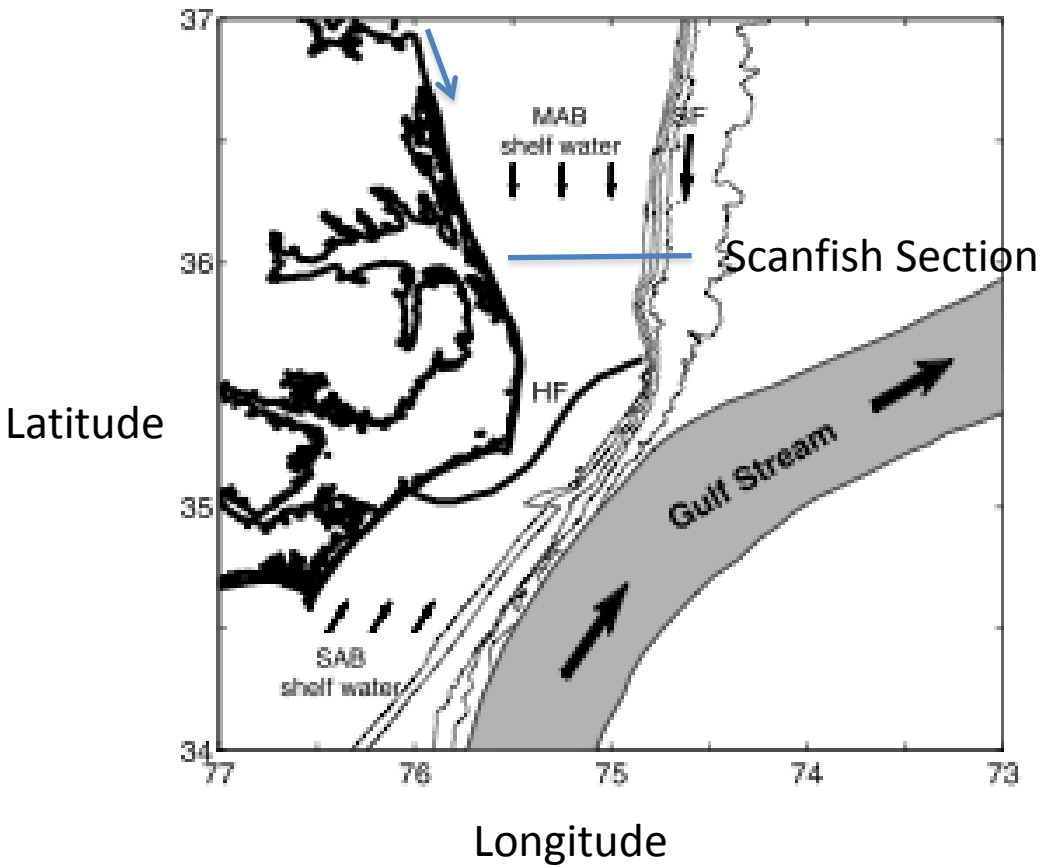
Salinity May 26



Temperature range is from 5-16° C
Contrast across shelfbreak front is about 6° C
Foot of front is at 110 m isobath

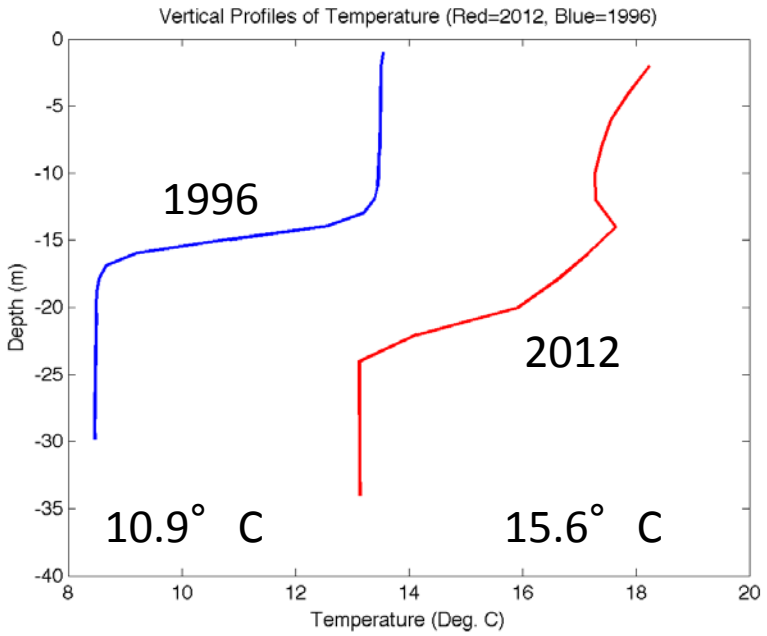
Salinity range is from 32-35 PSU

Cape Hatteras, 2012: An Unpleasant Surprise



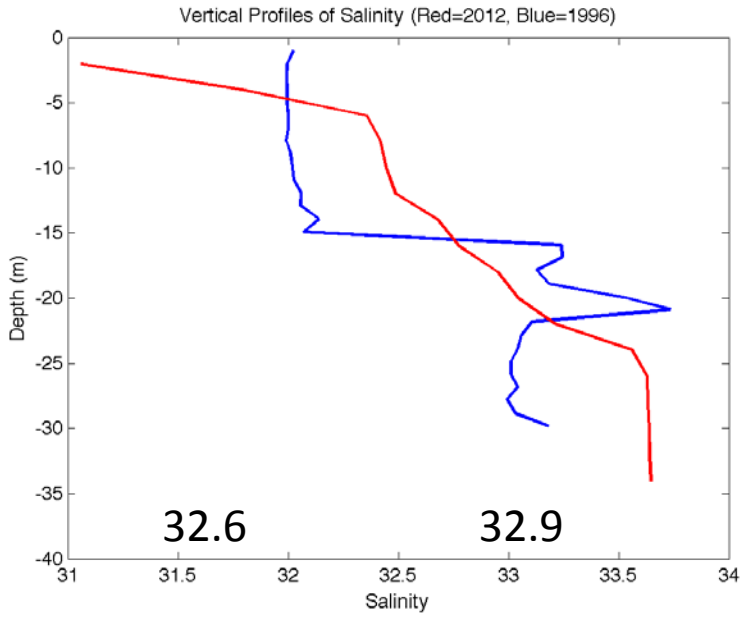
Comparison of mid-shelf vertical profiles from 1996 and 2012

Temperature



Mean (depth-averaged) temperature difference is 4.75° C warmer in 2012

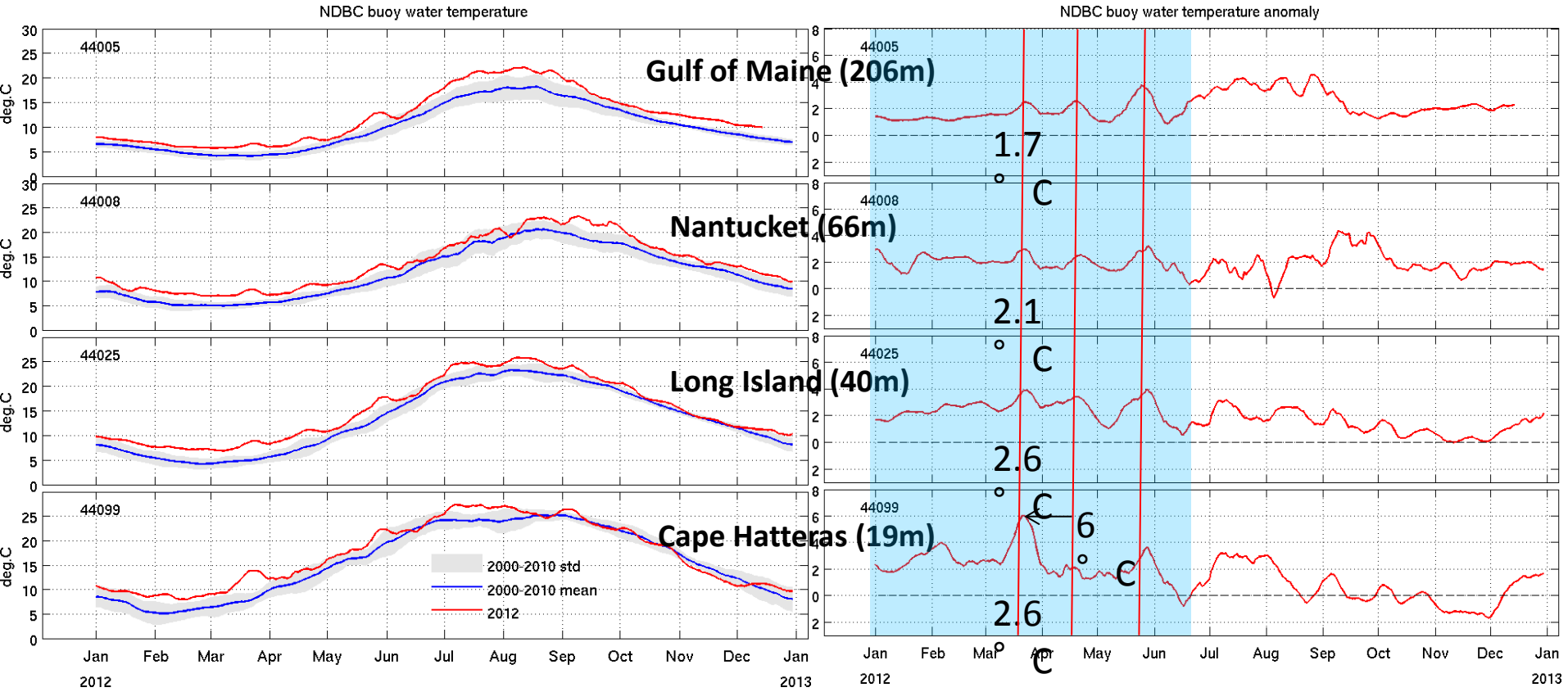
Salinity



Mean (depth-averaged) temperature difference is 0.28 saltier in 2012

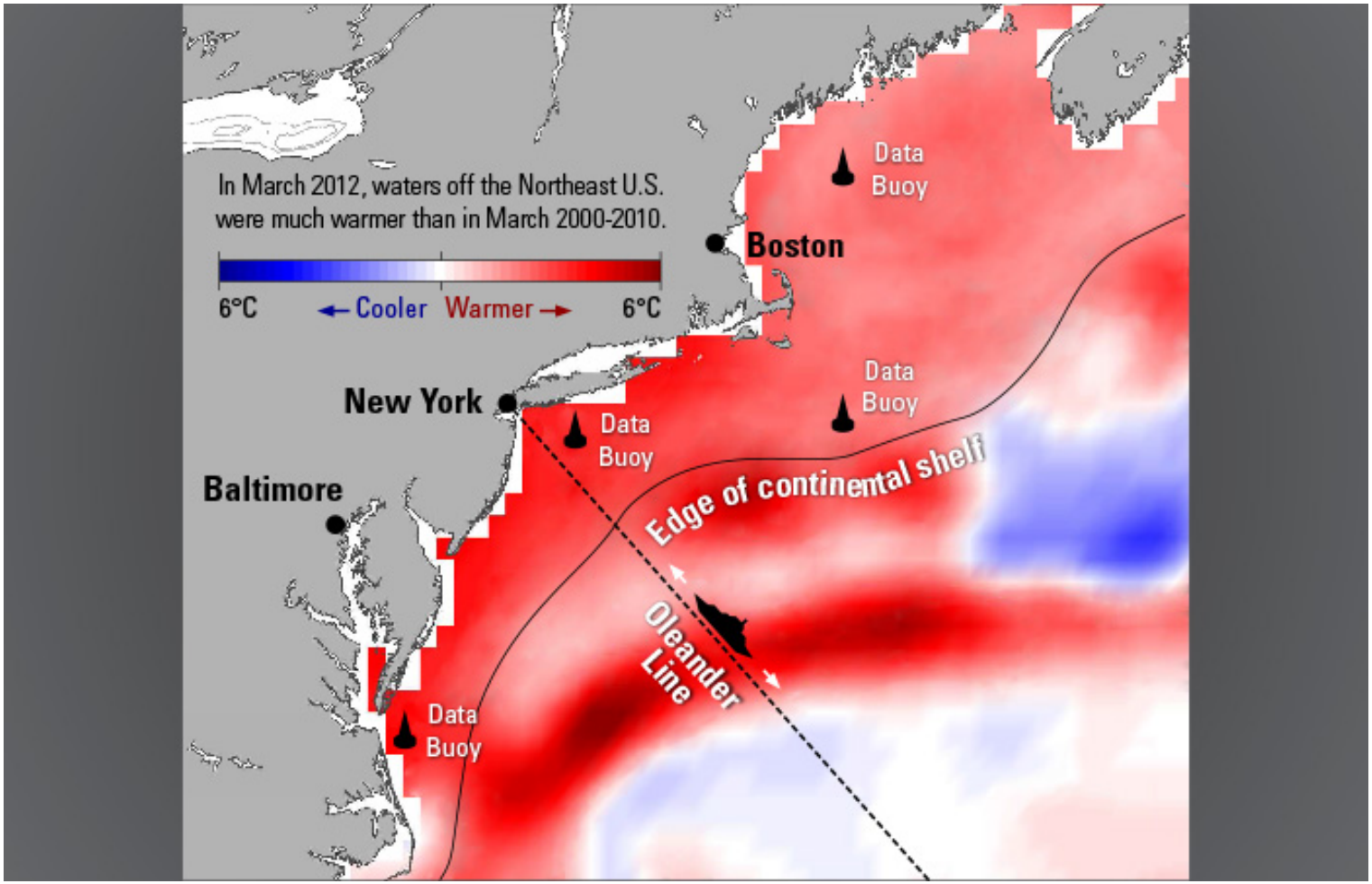
Net impact on depth averaged density- 0.8 kg/m^3 less dense in 2012

NDBC buoy temperature
Gulf of Maine to Cape Hatteras



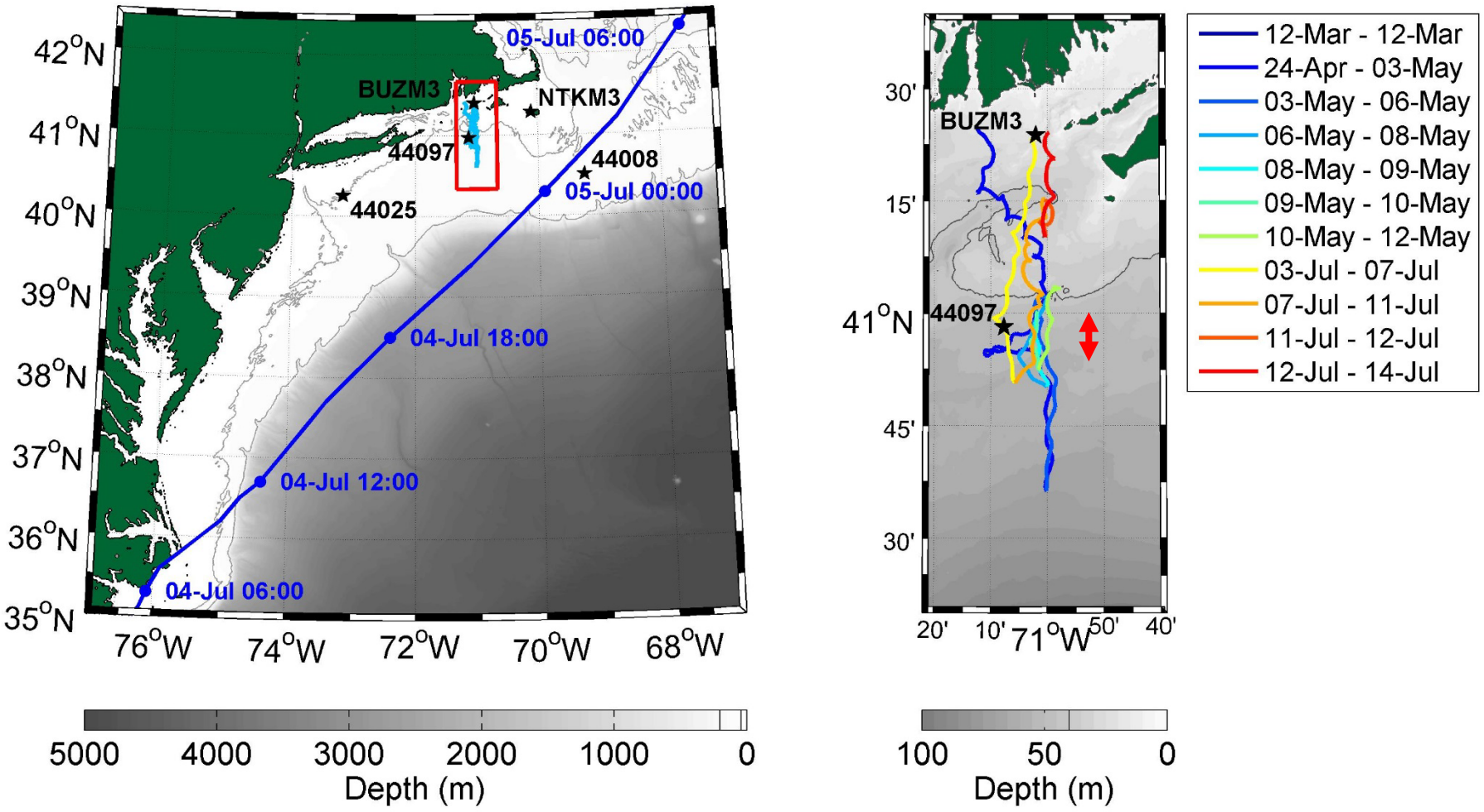
- The 2012 temperature is above average most of the time
- The magnitudes of anomalies vary from 0-6 ° C and the max anomaly is in Mar 2012 near Cape Hatteras
- The systematic shelf-wide warming occurs in the first half of 2012. On average, the magnitude is about 1.7-2.6 ° C. The duration is at least 6 months.
- In-phase variation of temperature anomalies

Temperature Anomaly, March 2012



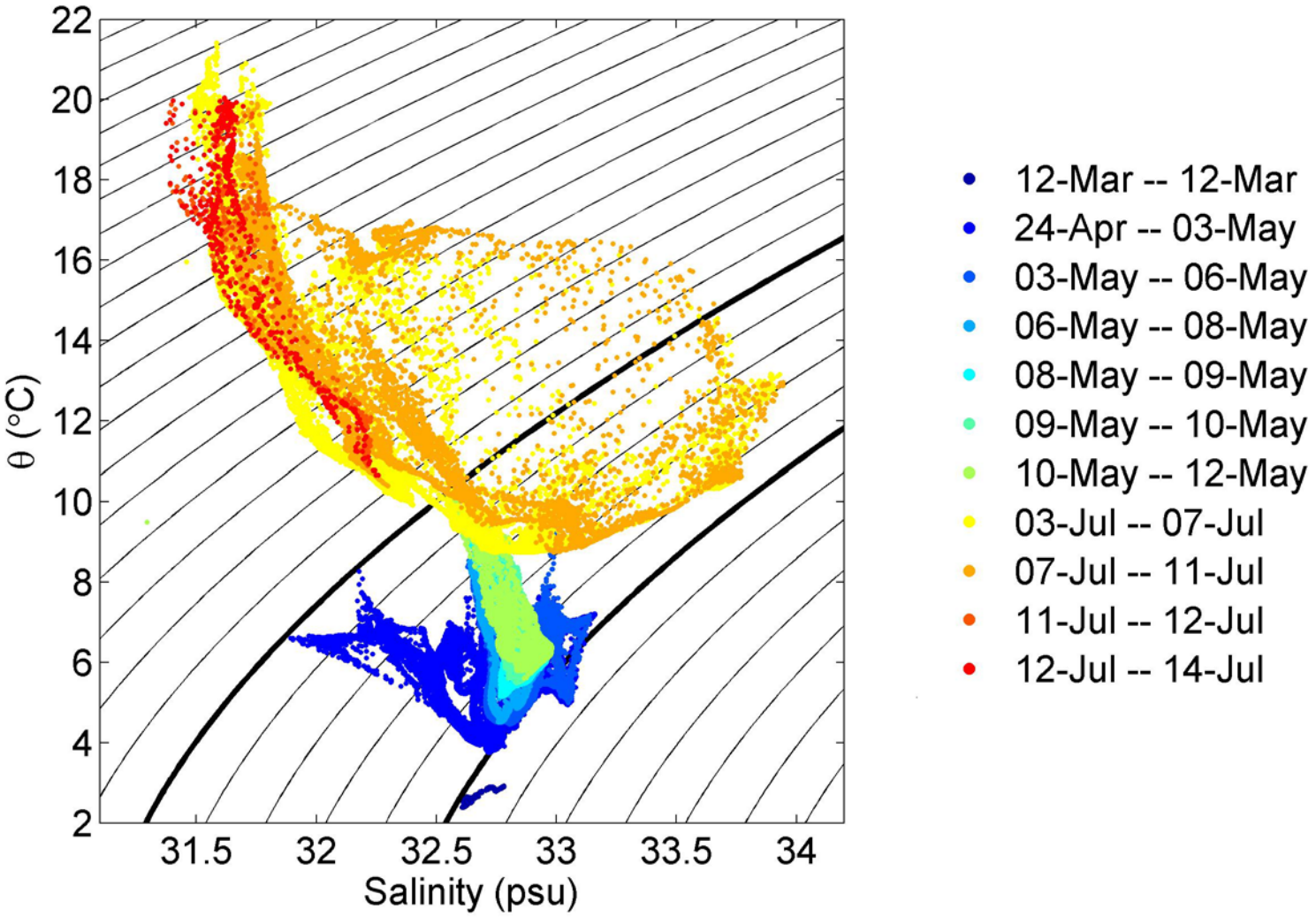
From Chen et al. (2014)

Glider Observations 2014



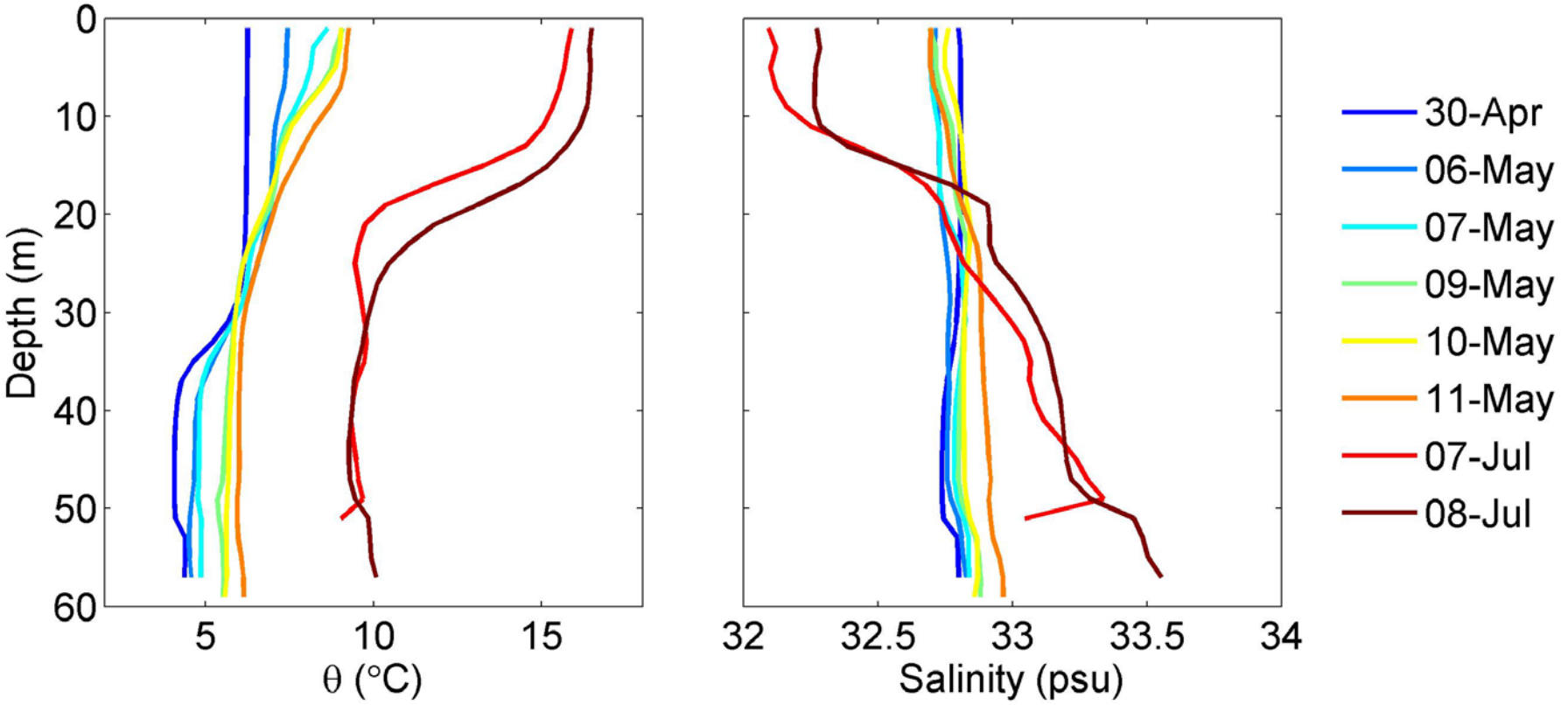
Buoy data from National Data Buoy Center (NDBC) & Hurricane Arthur track from National Hurricane Center (NHC)

Seasonal Evolution in Θ-S Space

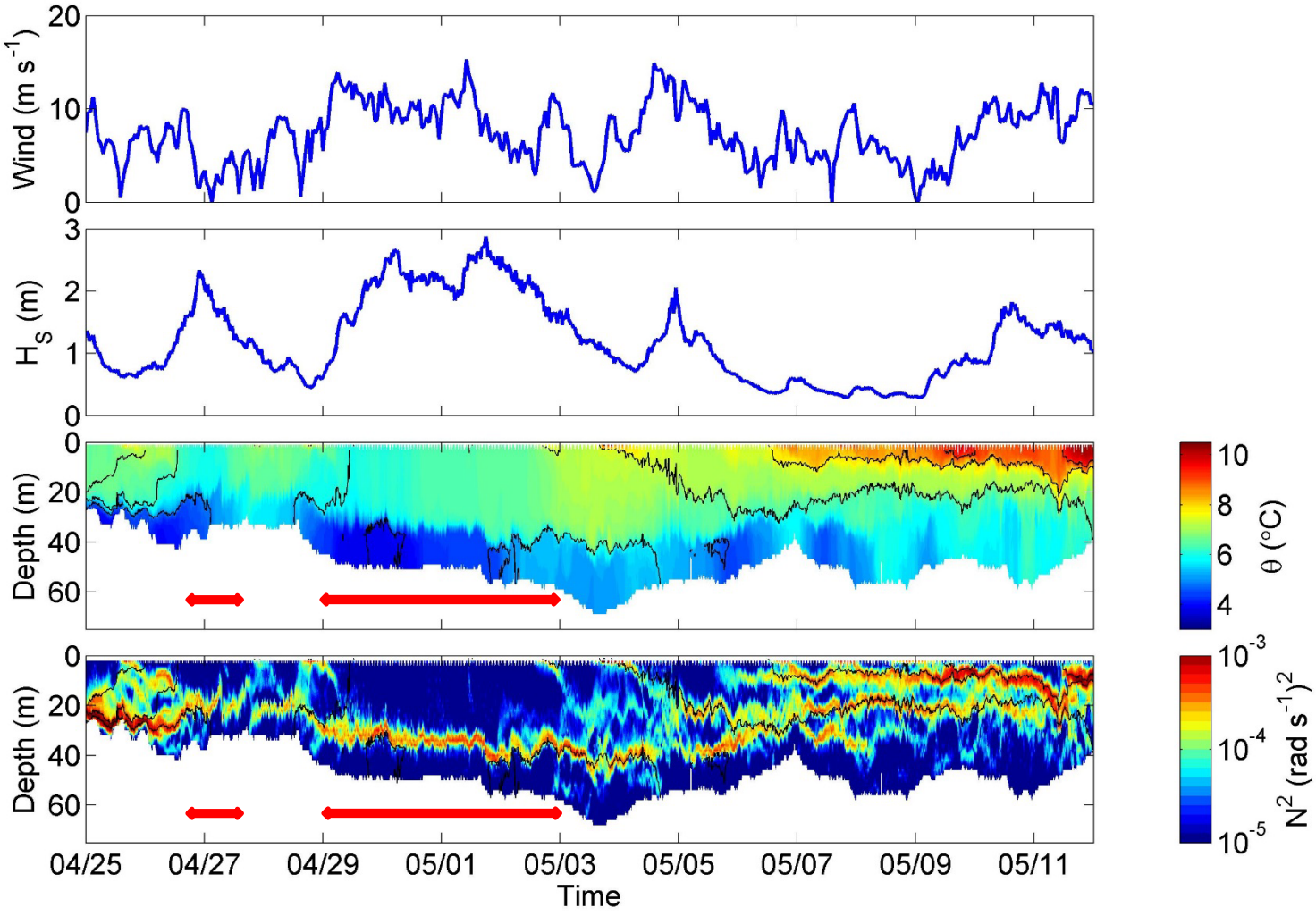


Seasonal Evolution with Depth

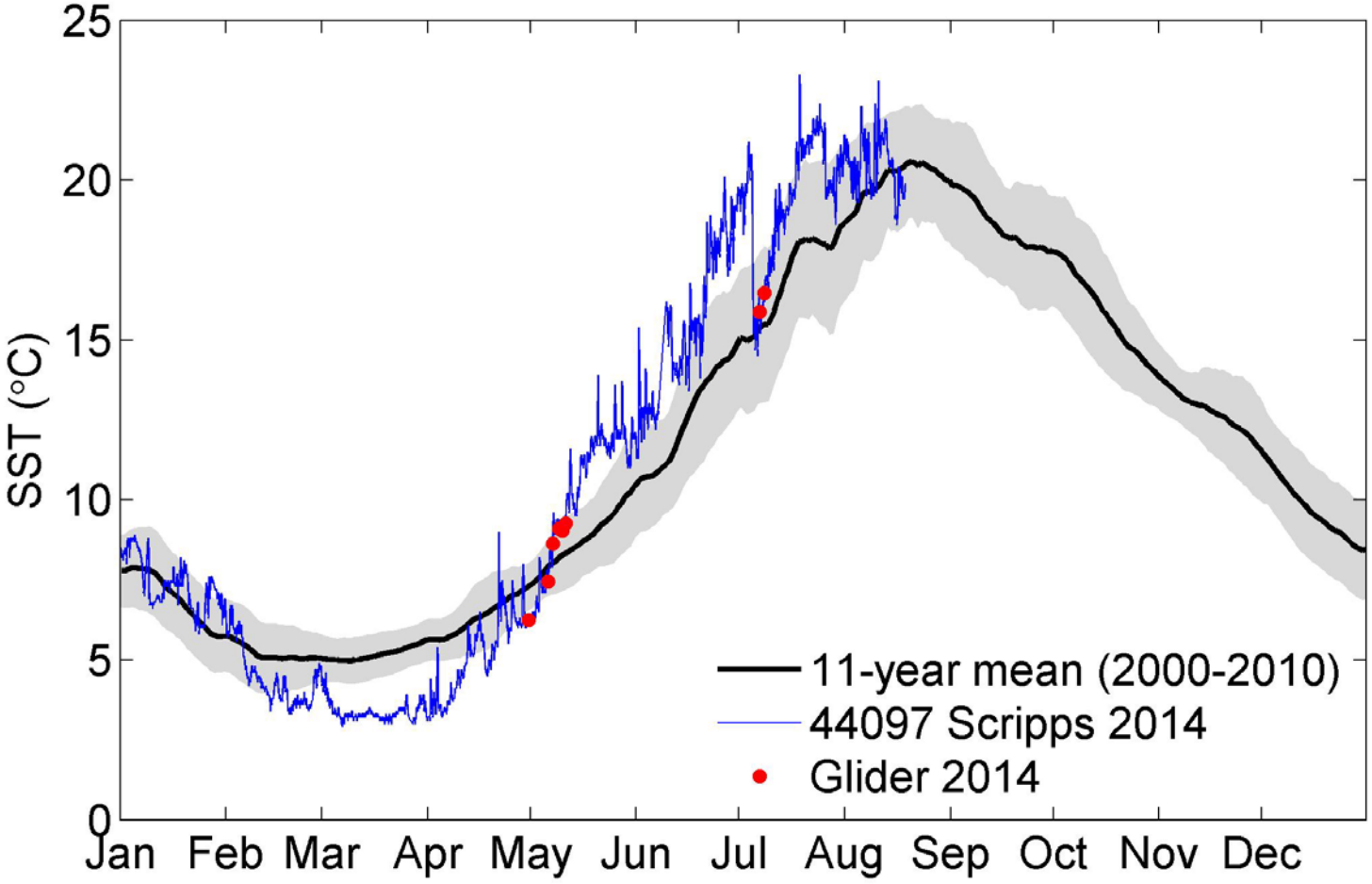
Profiles averaged for each section within the region from 40° 53'N to 41° N (bottom depth: 35-55m)



Winter Storms

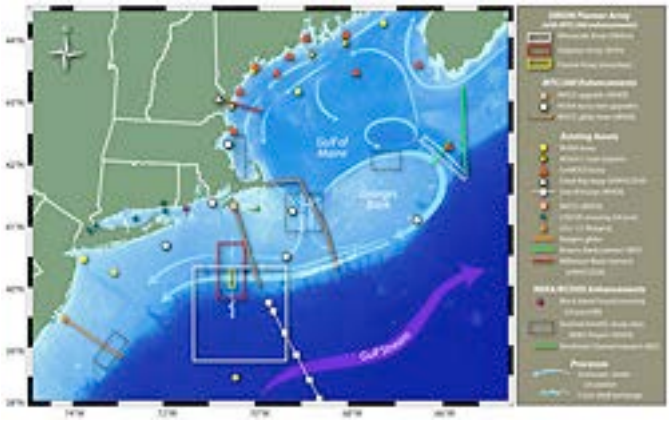


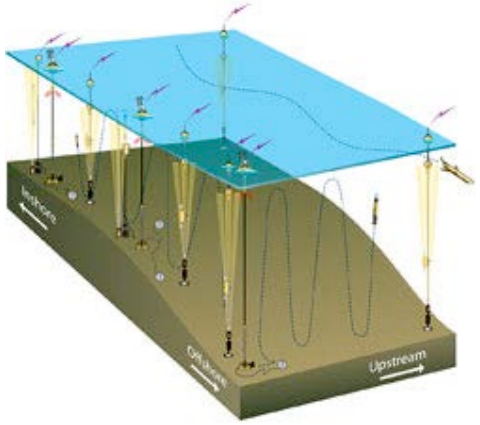
Climatology 44008 Nantucket Shoals



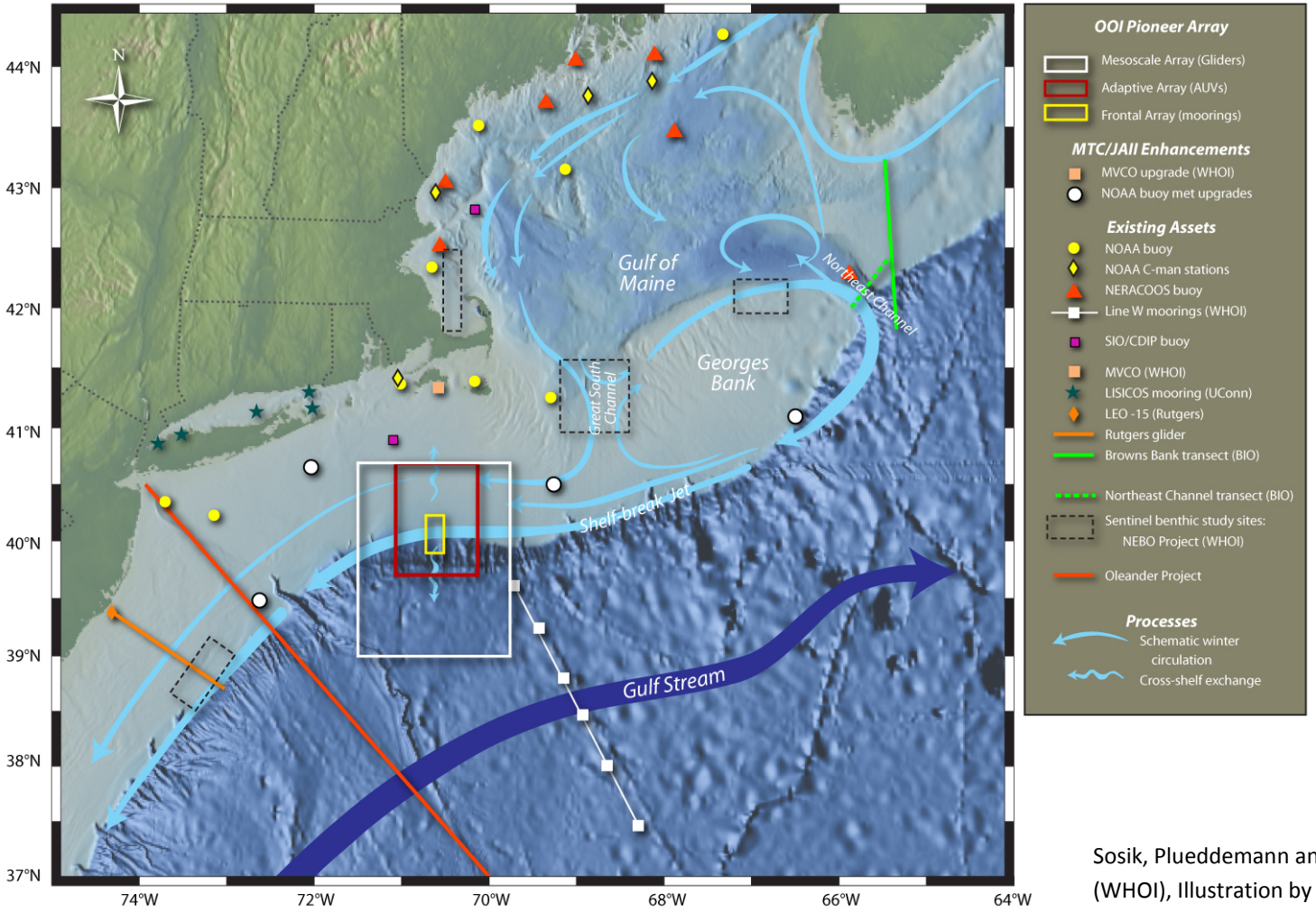
Coastal Observatories- Pioneer Array

- Focus on shelfbreak processes and nutrient exchange between shelf and slope
- Will move between regions every 5 years- off New England from 2015-2020
- Design was centered around AUV and glider surveys to resolve shelfbreak front and jet



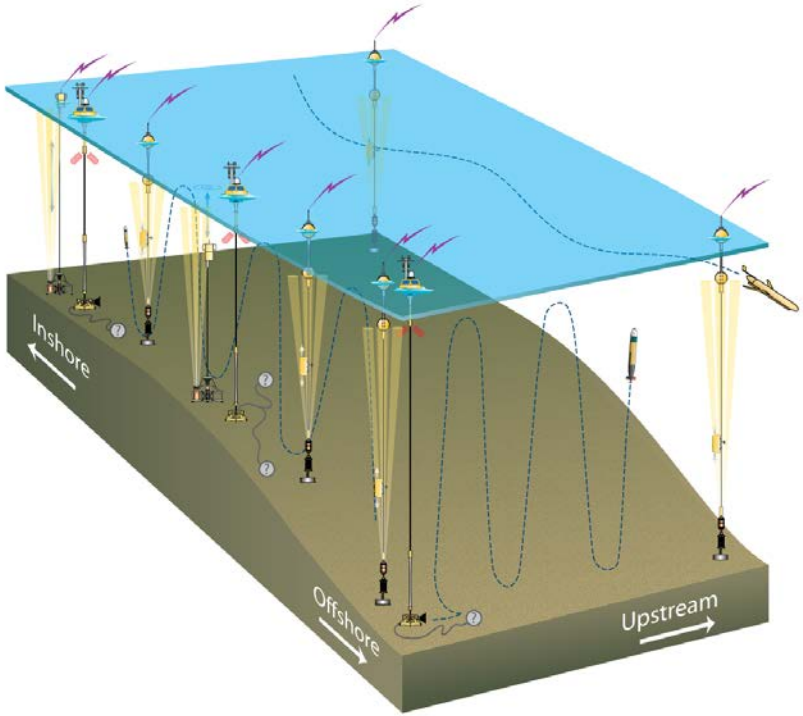


Pioneer Array Regional Context

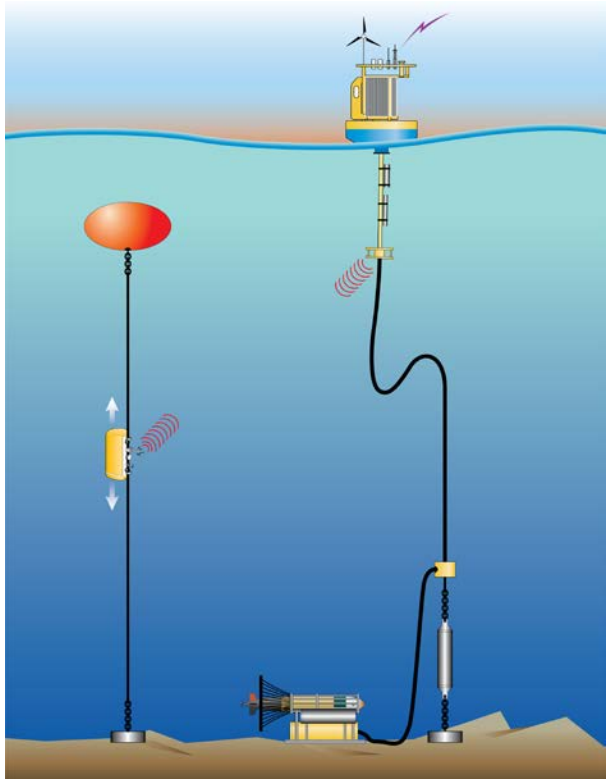


Sosik, Plueddemann and Trowbridge (WHOI), Illustration by Jack Cook

Ocean Observatories Initiative Pioneer Array (NSF)



Schematic of Pioneer Array



Docking station for AUV
Moored Profiler

Pioneer Array Configuration

Array Configuration
(circa Feb 2012)

Moored Array

47 km x 9 km

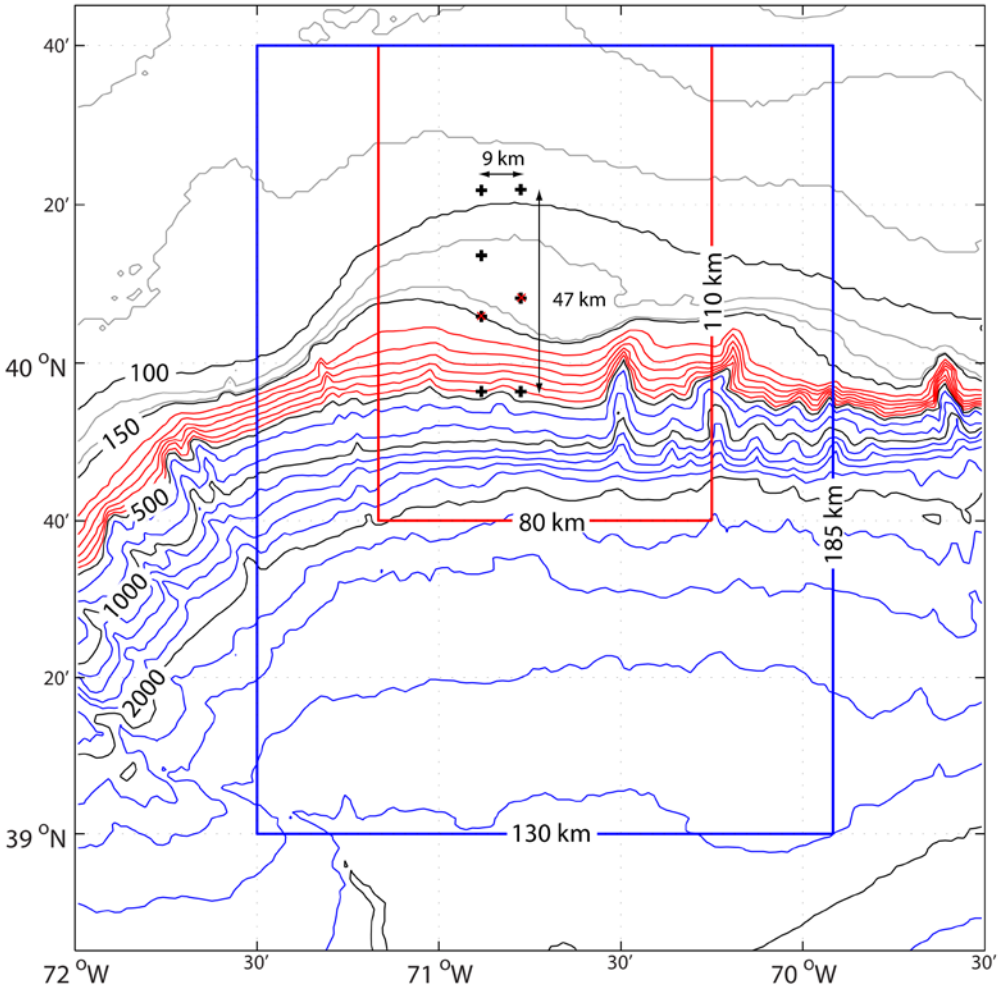
(90 m to 450 m depth)

AUV Operations

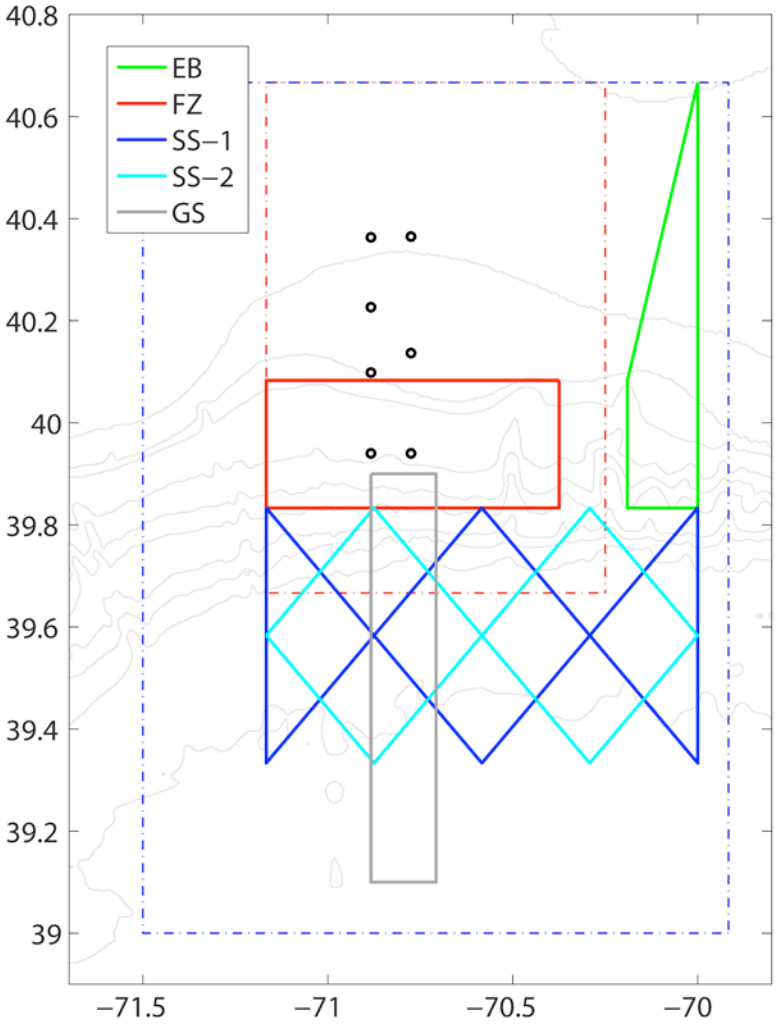
80 km x 110 km

Glider Operations

130 km x 180 km



Pioneer Glider Sampling Patterns

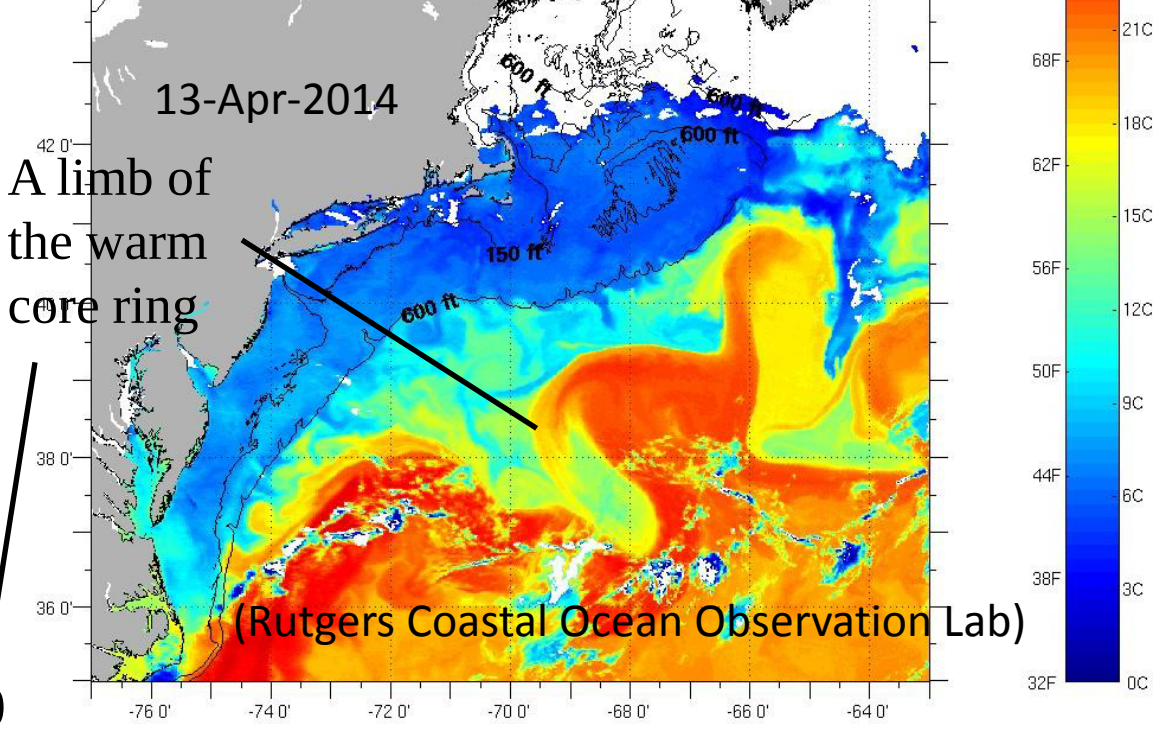


Pioneer Array Data Products

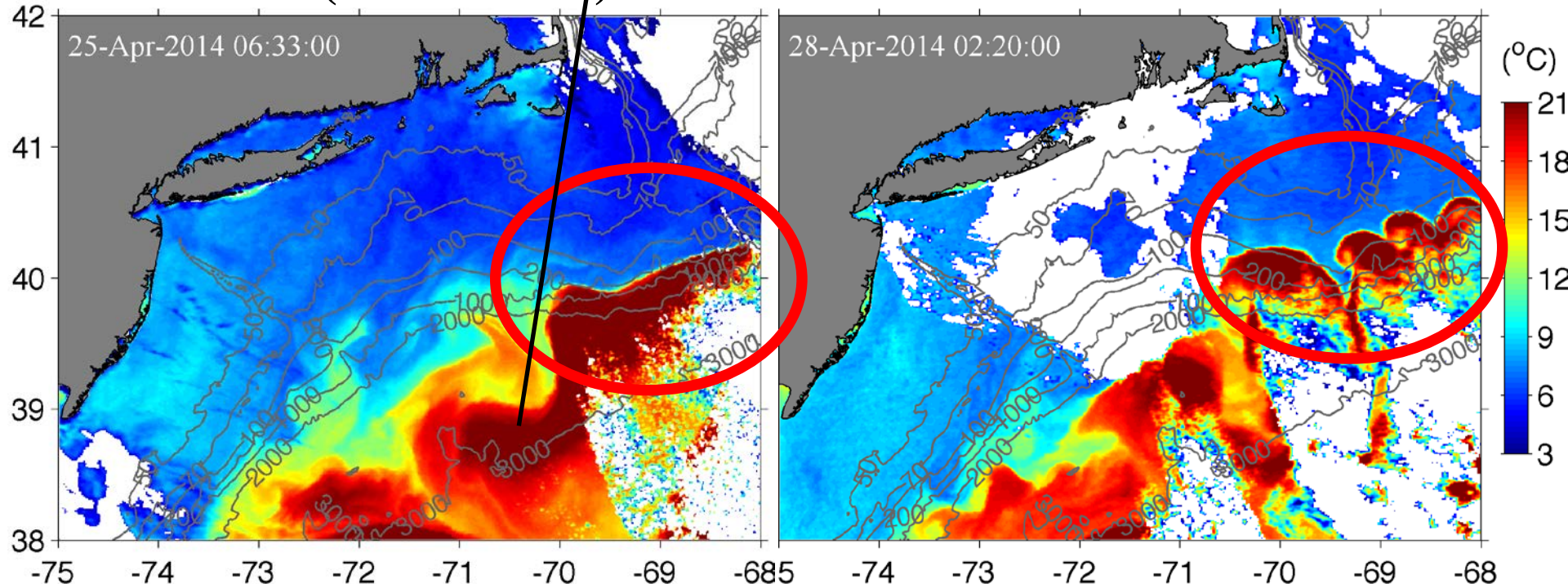
	Measurement Location		
Data Product	**Air-Sea Interface**	**Water Column**	**Seafloor**
Humidity	x		
Air temperature	x		
Precipitation	x		
Barometric pressure	x		
Wind velocity	x		
Fluxes - momentum, heat, and moisture	x		
Wave properties	x		
Temperature	x	x	x
Salinity	x	x	x
Density	x	x	x
Water velocity	x	x	x
Acoustic backscatter		x	x
Seafloor Pressure			x
Dissolved CO_2	x		x
Dissolved O_2	x	x	x
Apparent optical properties (downwelling irradiance, PAR)	x	x	
Inherent optical properties (absorption, attenuation)		x	x
Chlorophyll *a* (phytoplankton biomass estimates)	x	x	
Colored Dissolved Organic Matter	x	x	
pH (ocean acidity)	x	x	x
Nitrate concentrations		x	
Bio-acoustics (zooplankton and fish biomass estimates)		x	

Data Products Poster Ver. 0-21 05-30-2012

Another type of frontal instability at the shelfbreak and its implication on cross-shelfbreak water exchange



Satellite SST (zoom-in views)



Pioneer Array glider measurement

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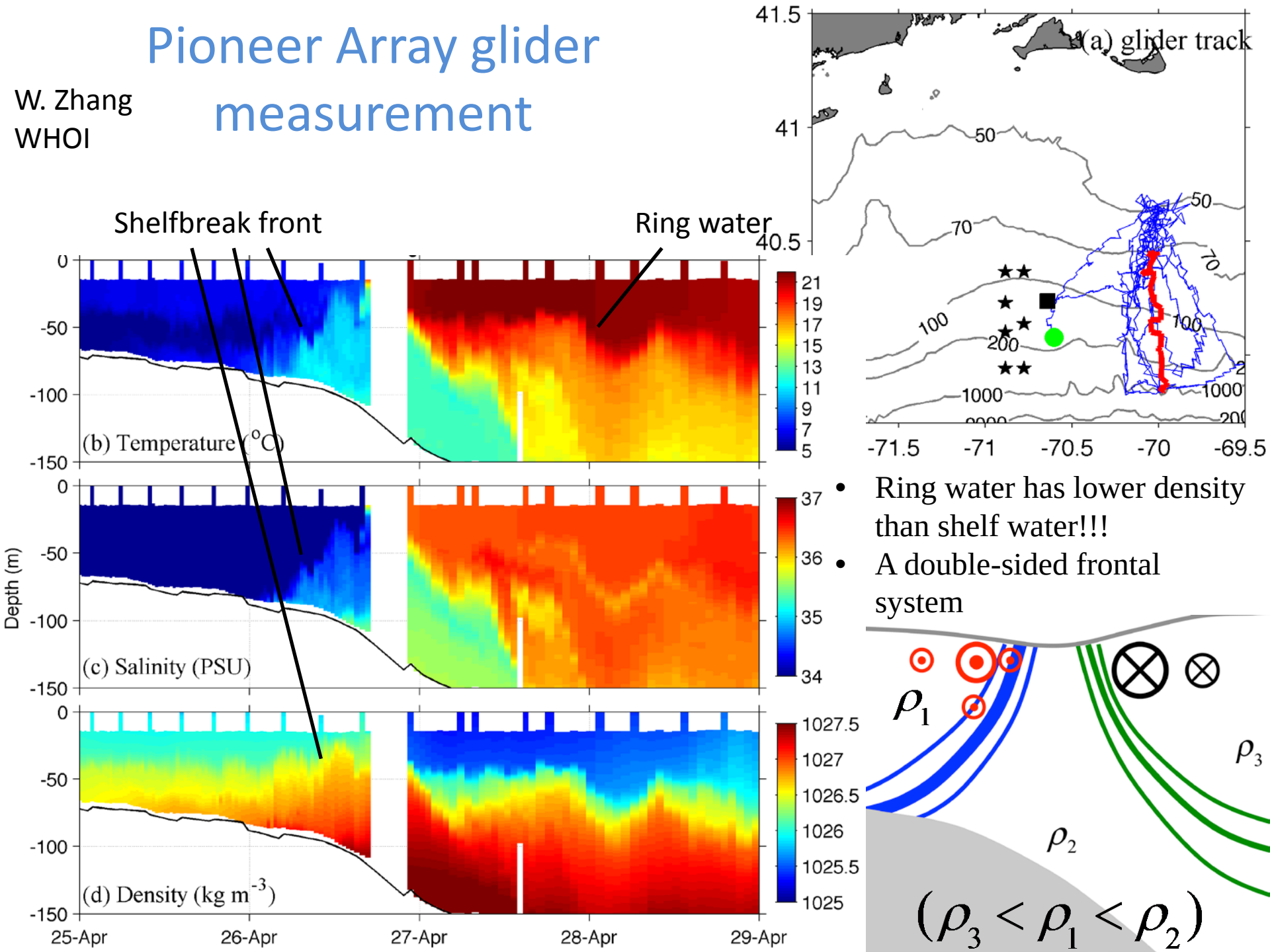
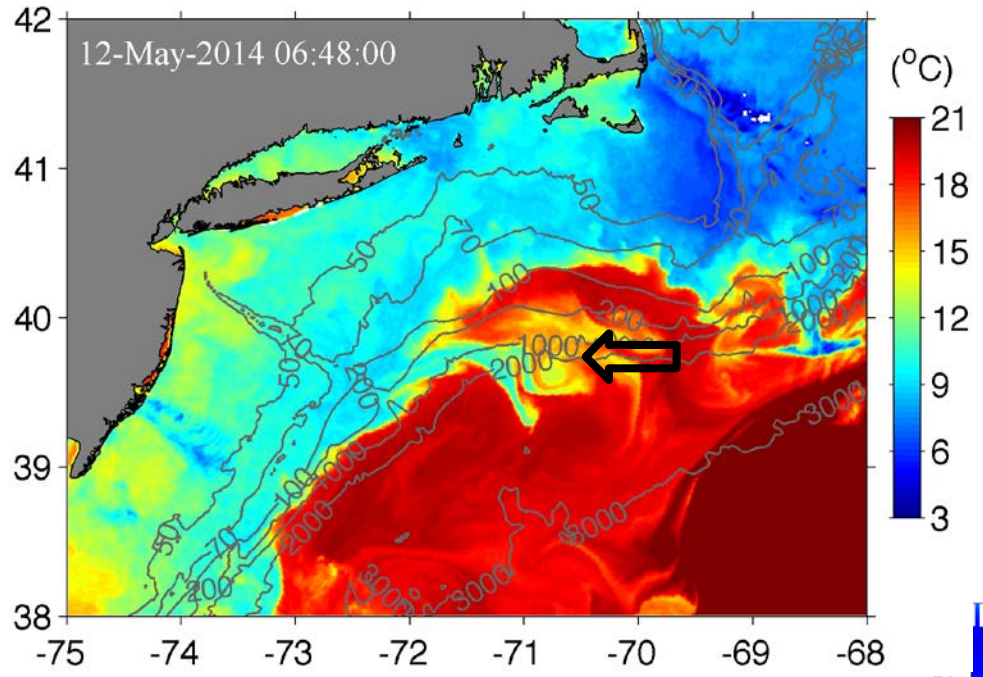
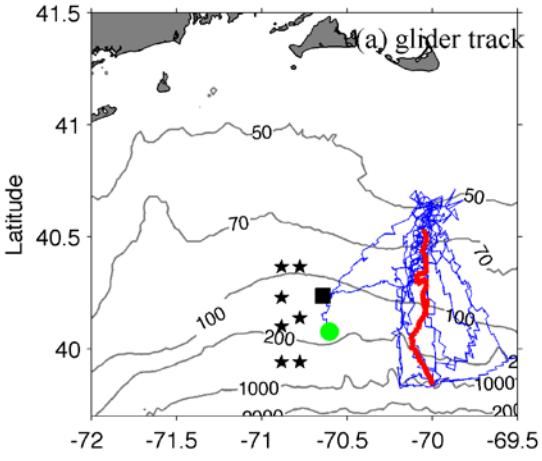
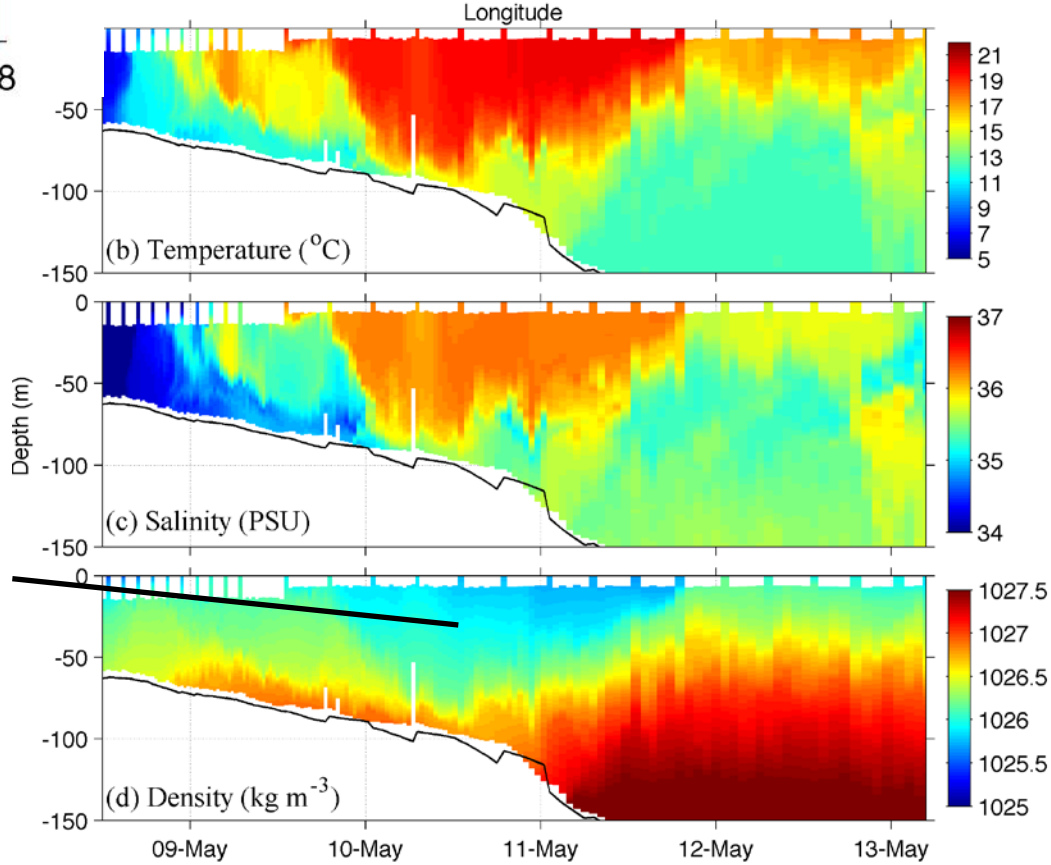


- Ring water has lower density than shelf water!!!
- A double-sided frontal system







The warm-core ring water flows westward along the shelfbreak

Ring water

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WHOI

Physical Oceanography Options for resolving oceanographic features and soundspeed variability

- Low-cost option- Examine Pioneer data during spring and summer 2015 and examine CTD casts from acoustics operations- ~80k
- Medium-cost option- Launch glider at start of pilot cruise, recover at end of cruise. Cycle between two geoacoustic sampling boxes- ~120k
- High-cost option- Scanfish surveys at beginning and end of Pilot cruise (likely 12 hours per survey) ~150k

Weekly data from Commercial Fishing Industry (jointly with Commercial Fisheries Research Foundation)