Recent Changes in Shelfbreak Exchange Processes in the Middle Atlantic Bight

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Special Issue on Ocean Observatories Initiative
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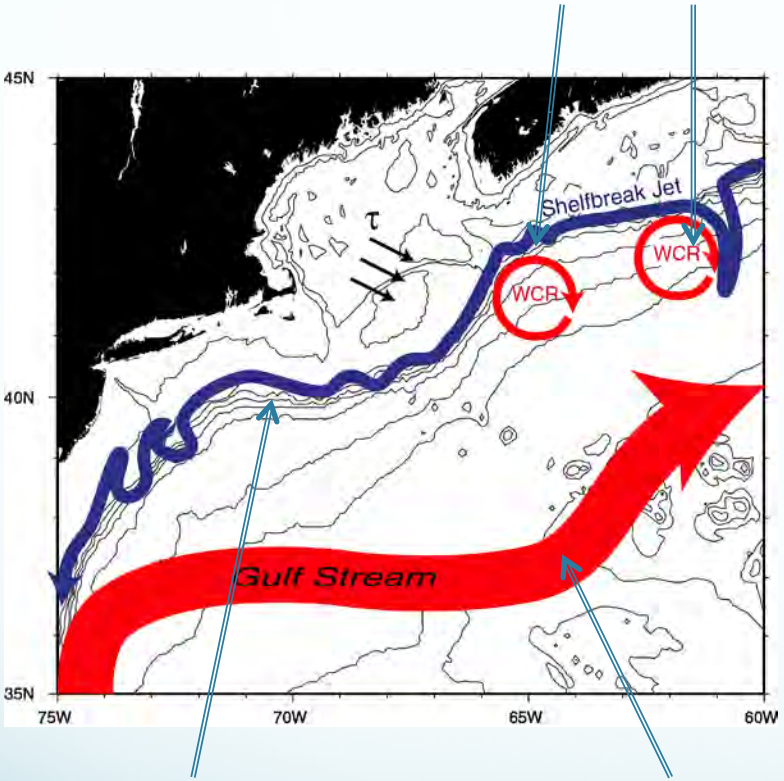
Outline

- Overview of regional circulation and shelfbreak exchange processes in the Middle Atlantic Bight
- New tools- the Ocean Observatory Initiative Pioneer Array and the CFRF/WHOI Shelf Research Fleet
- How are shelfbreak exchange processes changing?- influence warm core ring intrusions onto shelf
- Conclusions

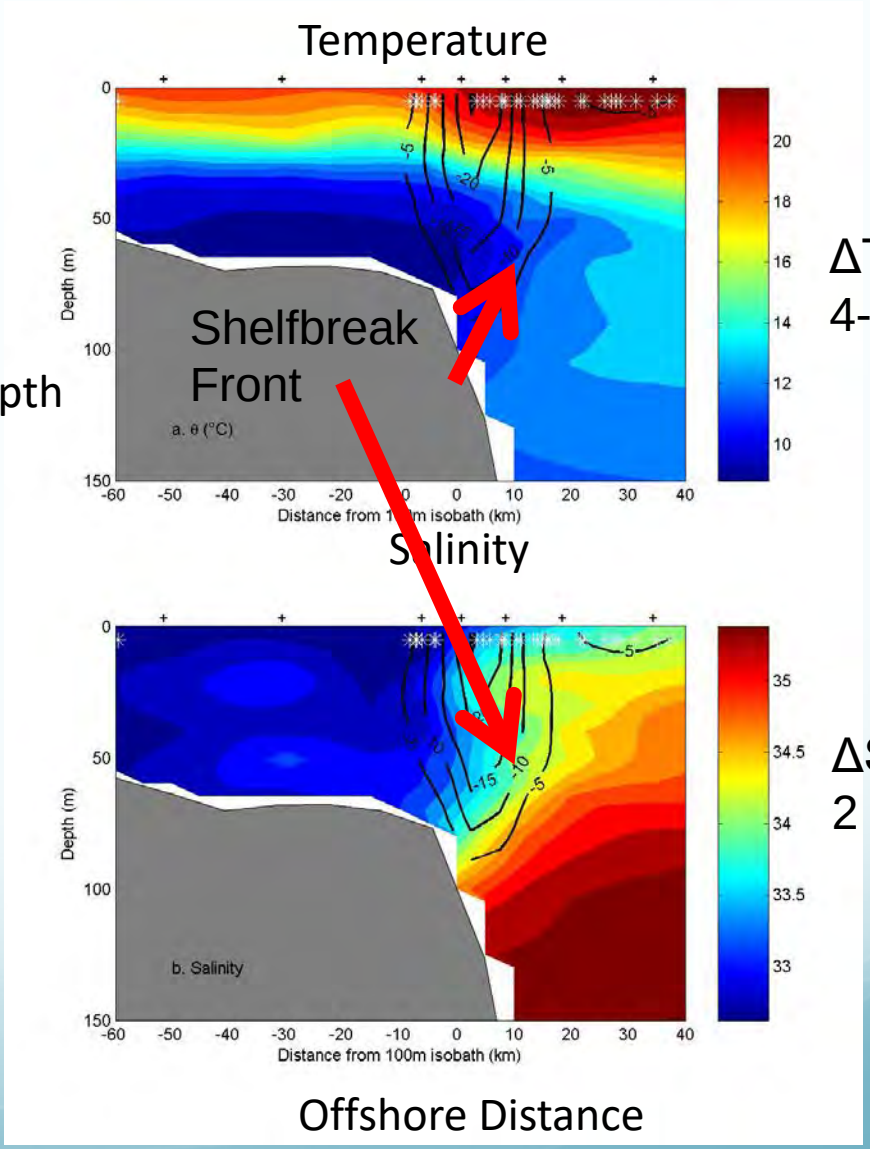
Background- Regional Circulation



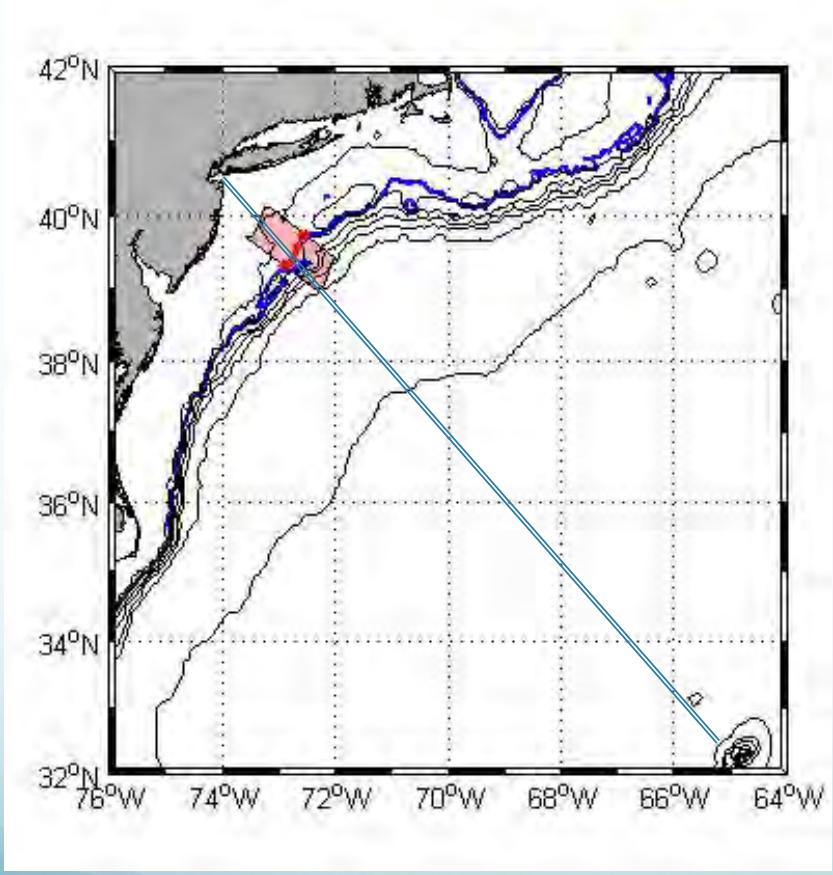
The Shelfbreak Jet and the Gulf Stream

Figure courtesy
P. Fratantoni

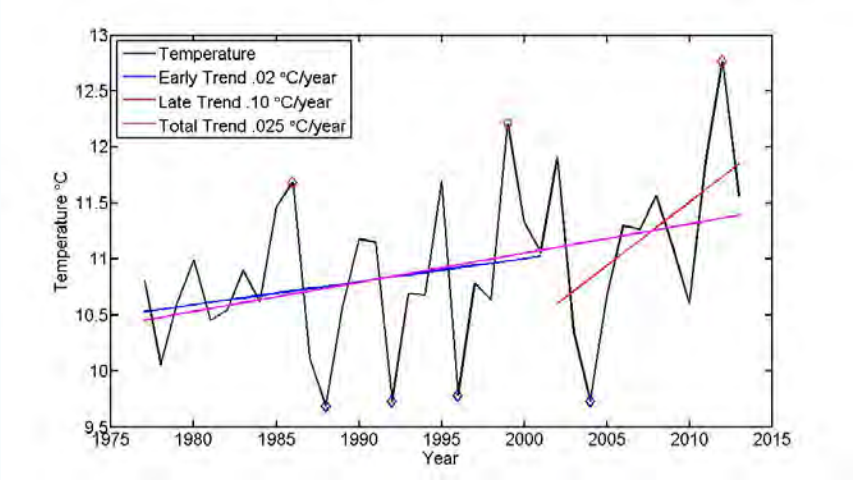
Cross-shelf View- Summer



Significant Warming in Middle Atlantic Bight
Annual New Jersey Shelf Temperature
1977-2013



MV Oleander
Ocean measurements since 1977



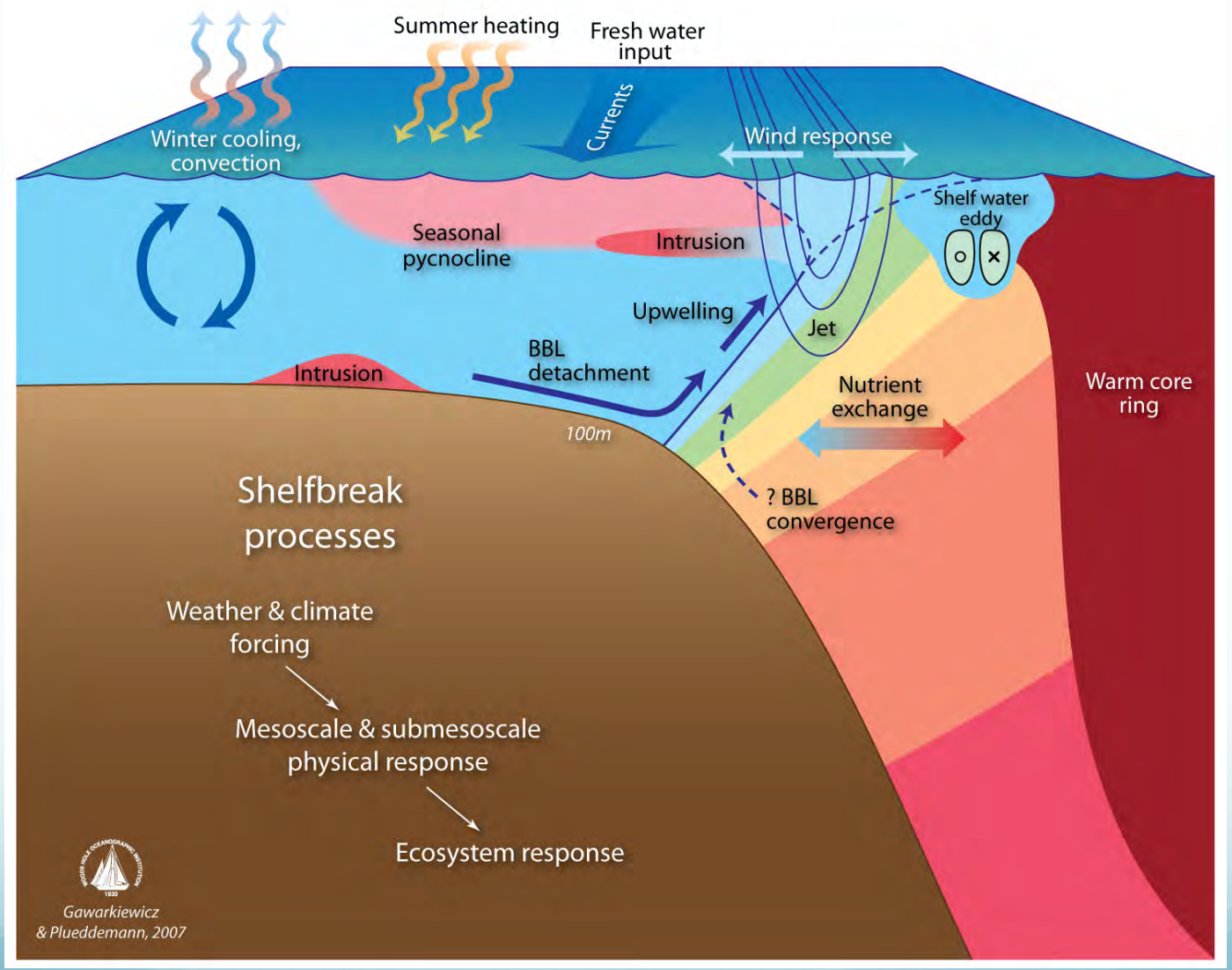
Warming Trend is 5 times faster
In 2003-2013 than 1977-2013

Warming Trend is 15 times faster
In 2003-2013 than 1880-2004

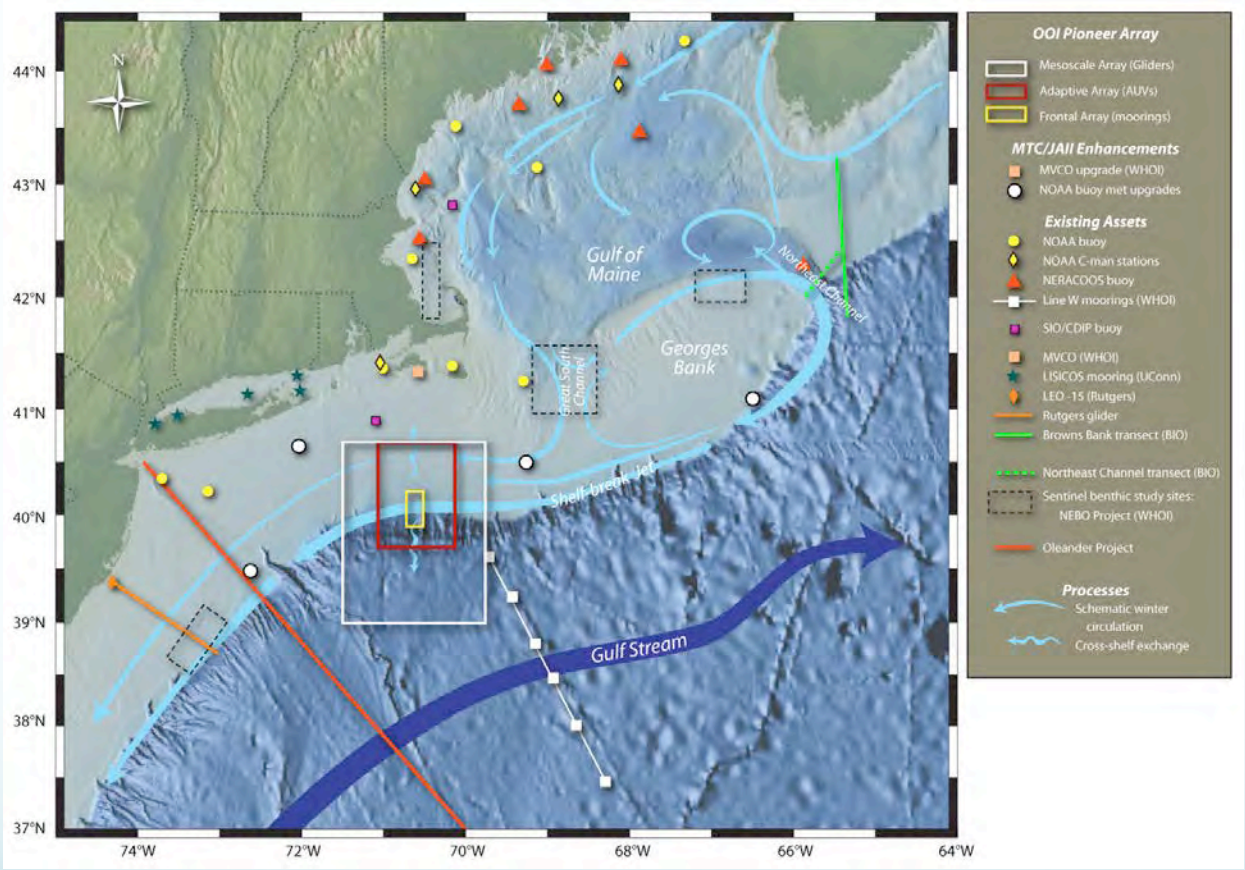
Warming concentrated at shelfbreak

From Forsyth et al. 2015

Shelfbreak Exchange Processes- How have these changed in recent years?



A new tool to study Shelfbreak Processes: the OOI Pioneer Array



Yellow Rectangle- Mooring Array
Red Rectangle- AUV operational area (REMUS 600)
White Rectangle- Glider operational area (Slocum)

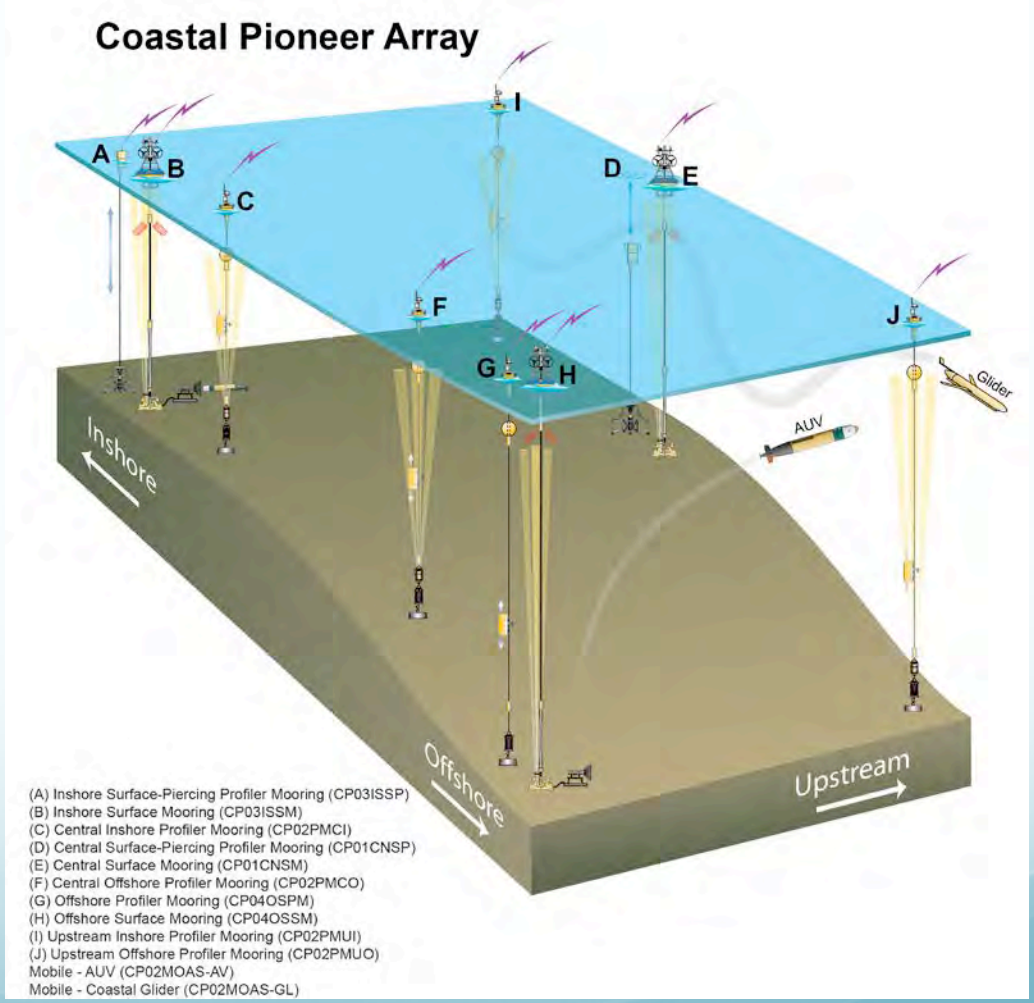
Pioneer Array Components

Seven mooring sites- Temporal variability

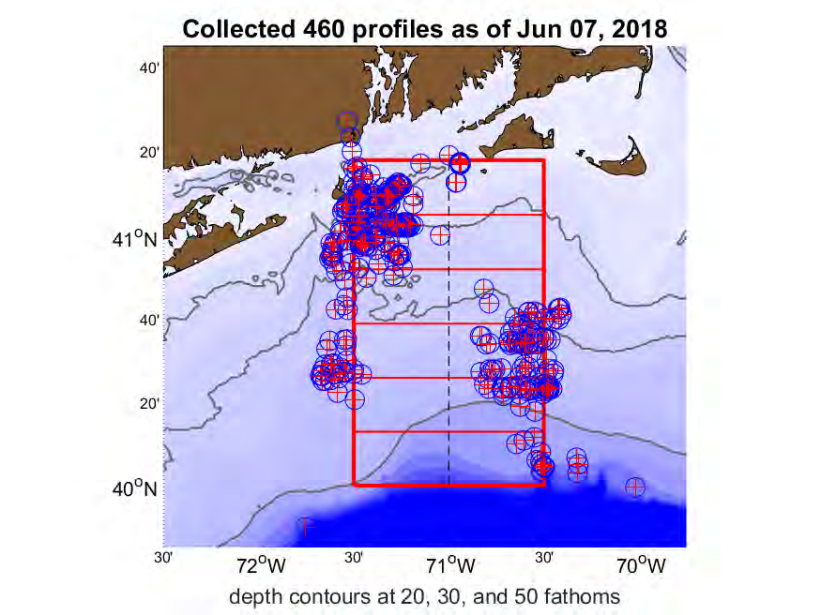
Six gliders- upstream water mass properties, slope features over continental slope

REMUS 600 AUV- Detailed shelfbreak frontal structure, optical nitrate sensor

Deployed in 2014, in operation for five more years



Shelf Research Fleet- Commercial Fisheries Research Foundation (R.I.)/WHOI



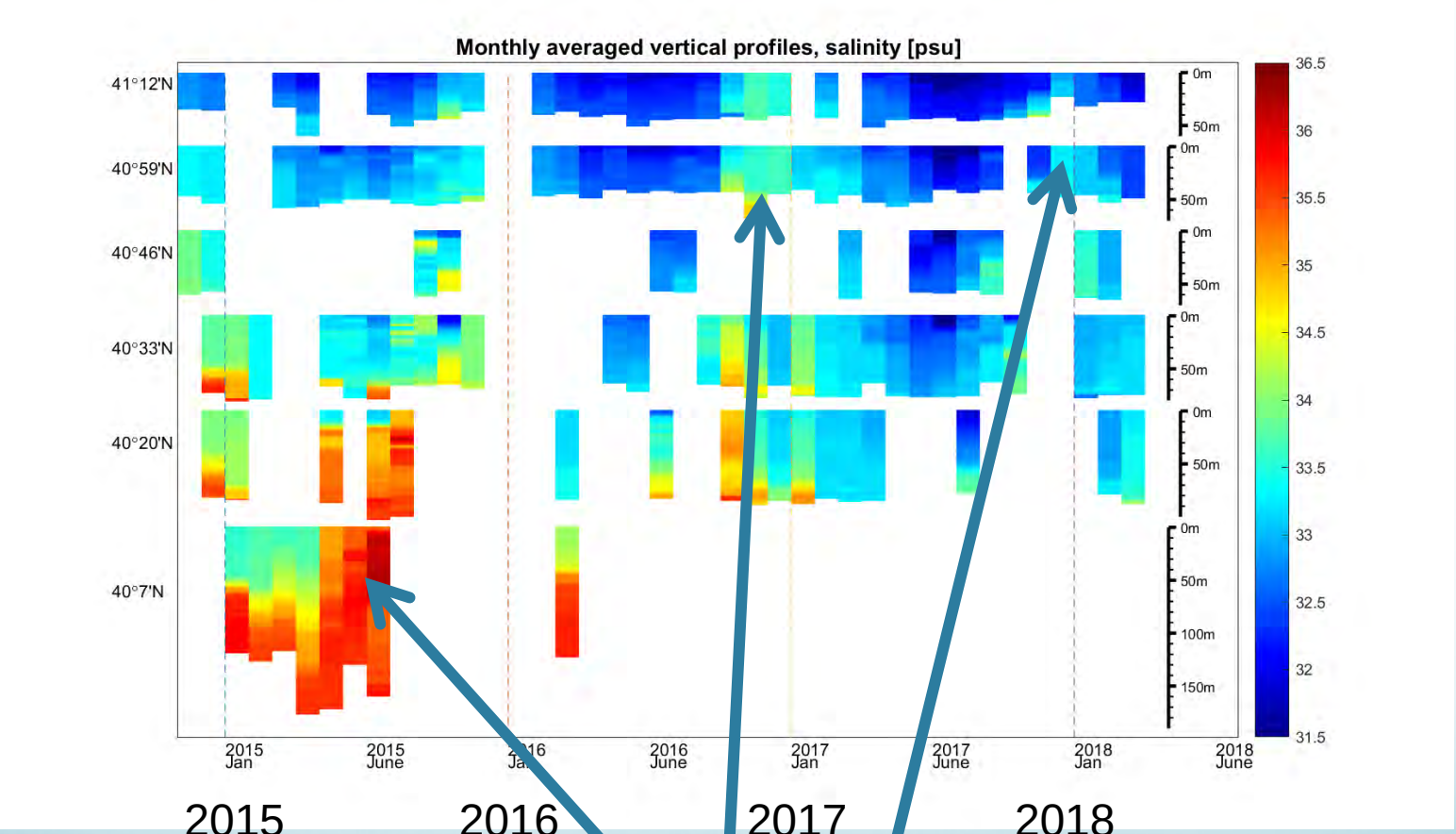
On fishing boat off Point Judith RI

Meeting at Commercial Fisheries Center (URI)

Collecting temperature and Salinity data since Nov. 2014 (funding from MacArthur/ van Beuren Foundations)

Shelf Research Fleet Data November 2014-May 2018

Monthly averaged salinity in six cross-shelf zones



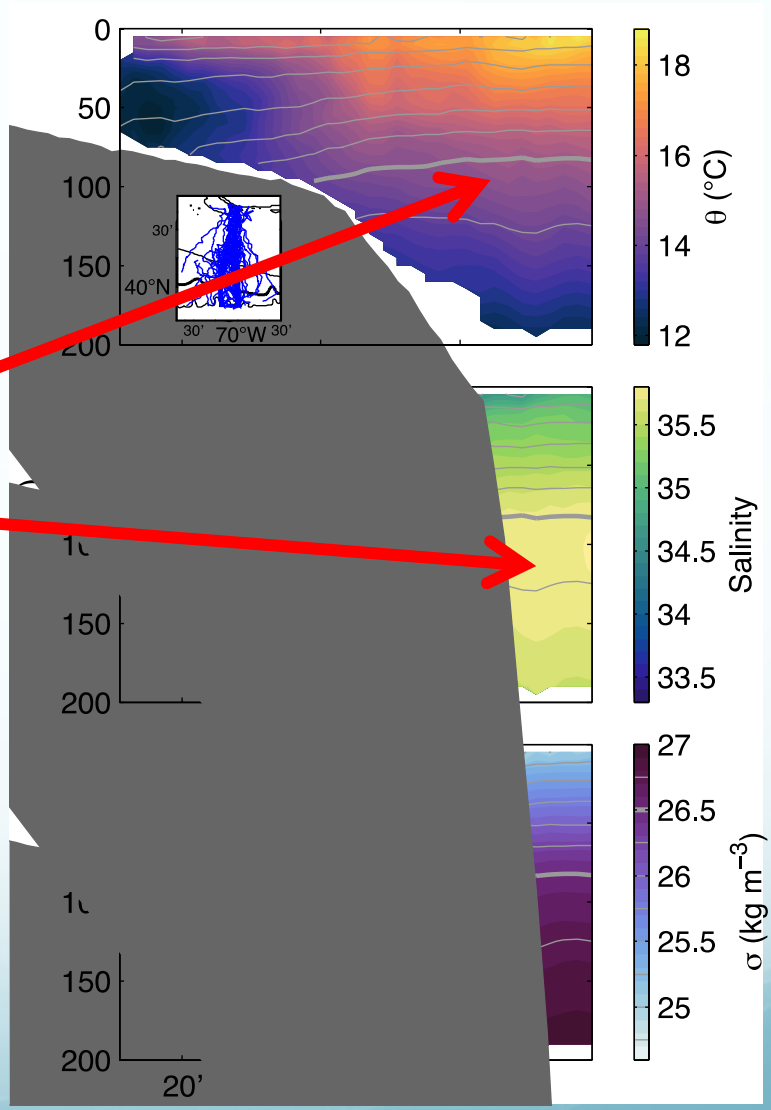
Glider Section Mean from the first 2.5 years- Gawarkiewicz et al. 2018

Mean section of glider sections over 2.5 years (April 2014-Dec. 2016) 78 total cross-shelf transects (R. Todd)

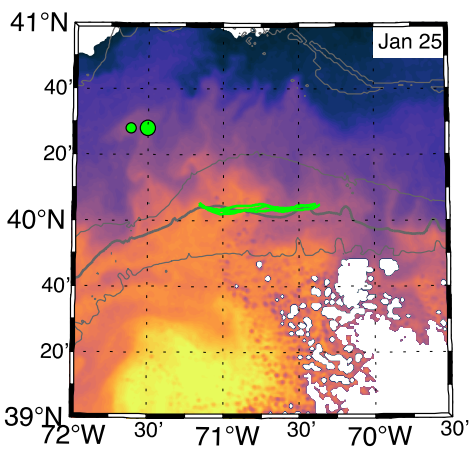
Upper slope thermostad warmer (2°C) and more salty (0.7 PSU) than climatology from 1976

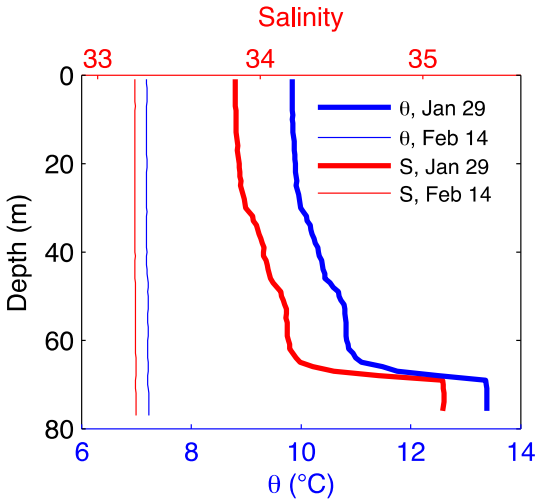
Confirms major impact of Gulf Stream water masses influencing upper slope

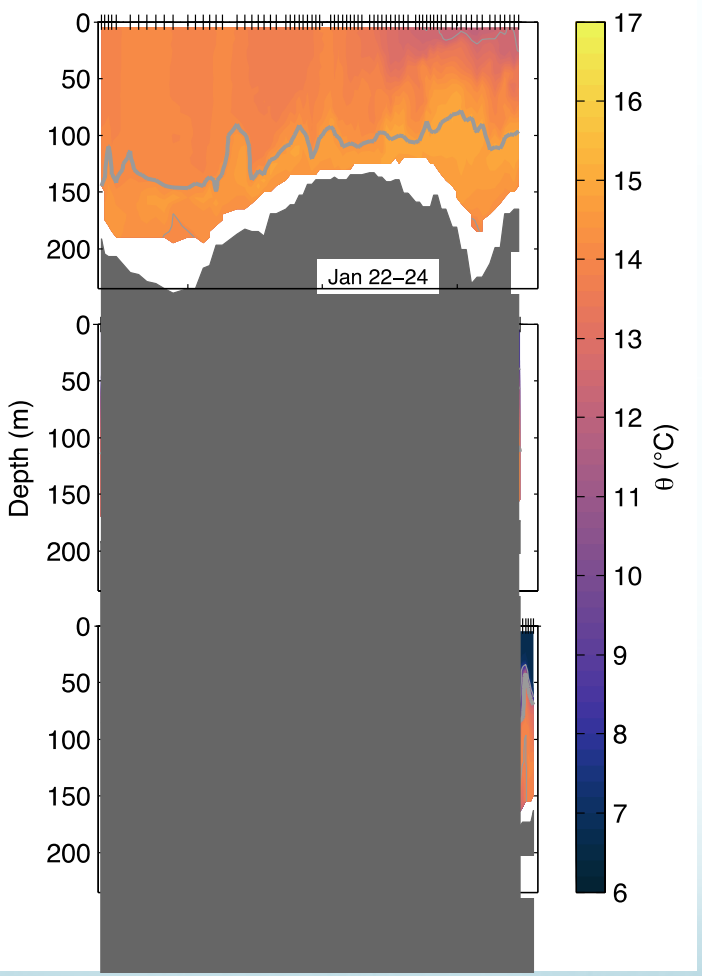
Foot of shelfbreak front at climatological position (100 m)



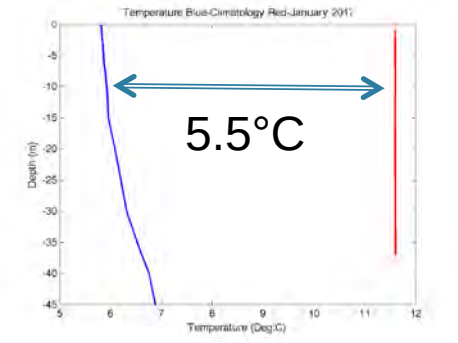
Massive Ring Intrusion- January 2017







Climo 1/17



10°C surface temp. 100 km shoreward of shelfbreak

Temp. anomaly >5°C

Salinity anomaly >1.5 PSU

Ecosystem Impacts- January 2017

- Warm water species caught near Block Island, RI (Gulf Stream flounder)
- Juvenile black sea bass caught over continental shelf first time in winter
- Spatial shifts in catch of Jonah crab
- Large salinity anomaly detected north of Cape Hatteras in late April- likely advected to Cape Hatteras in ~2-3 months

Massive ring intrusion Sept. 2014

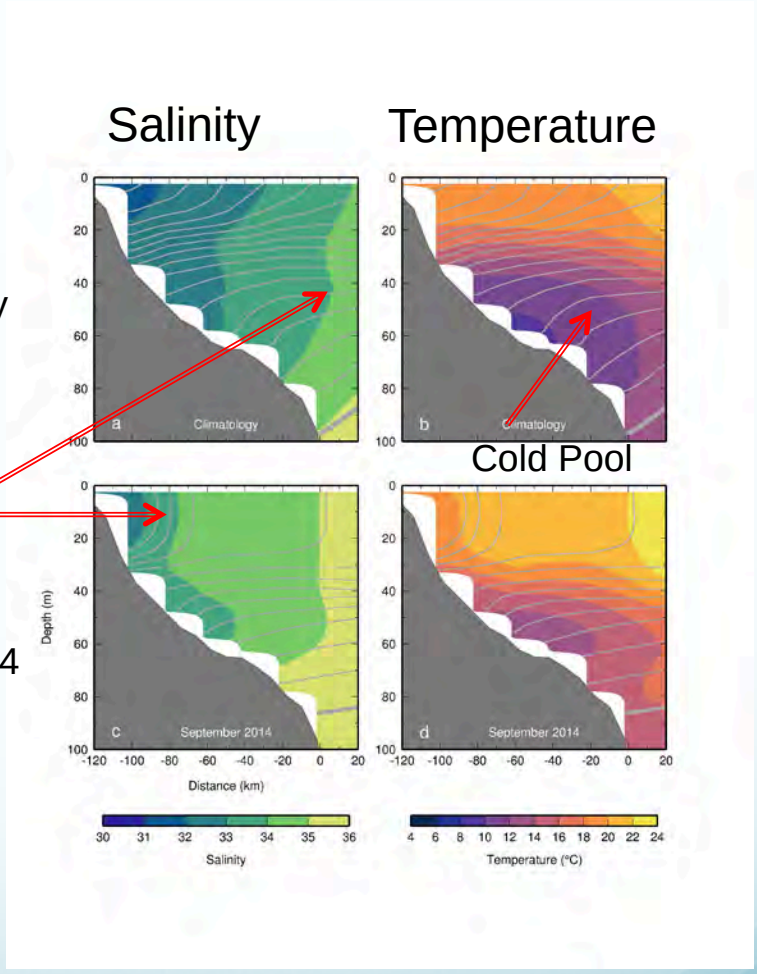
Shelfbreak front >70 km shoreward of shelfbreak

No Cold Pool (temperature minimum 13°C, Cold Pool < 10°C)

Isohalines tilt in wrong direction

Salinity anomalies are 5 standard deviations from mean!!!

Conclusive evidence that nature of shelfbreak exchange has changed in recent years



From NMFS Ecosystem Monitoring Cruises
P. Fratantoni (NEFSC)

Conclusions

- Significant ring intrusion events have been detected by Pioneer Array and Shelf Research Fleet across continental shelf south of New England in January 2017 and September 2014
- Warm salty ring water has penetrated significantly greater distances onshore than in previous observations of ring interaction with the continental shelf in 1980s and 1990s
- Can predictive climate models account for these huge impacts on shelf- 5°C warm anomalies and 1 PSU saltier for ~ 2 months?
- How does ecosystem respond to extreme shelfbreak exchange events?