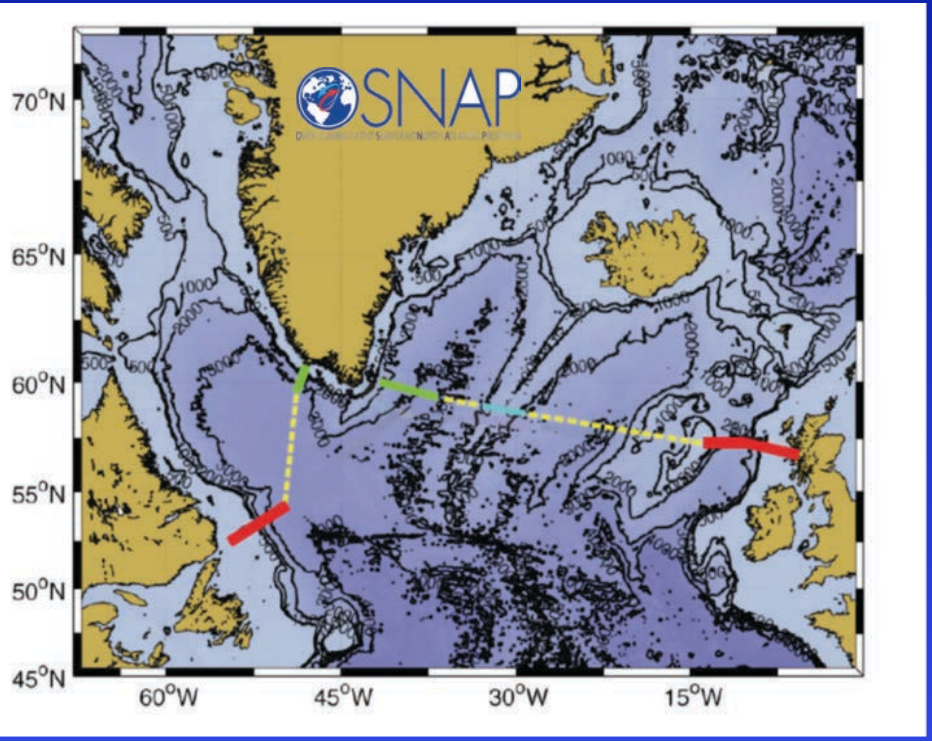
OSNAP: Overturning in the Subpolar North Atlantic Program

A US-led program with UK, Germany, Netherlands, France, Canada and China



U.S. : Susan Lozier (Duke); Bill Johns (U. Miami); Amy Bower, Bob Pickart and Fiamma Straneo (WHOI)

UK: Sheldon Bacon, Penny Holliday and Chris Wilson (NOC); Stuart Cunningham and Mark Inall (SAMS); David Marshall and Helen Johnson (Oxford) and Ric Williams (Liverpool)

Netherlands: Laura de Steur (NIOZ)

Germany: Jürgen Fischer and Johannes Karstensen (GEOMAR)

Canada: Blair Greenan (BIO); Brad de Young (Memorial U.)

France: Herlé Mercier, Virginie Thierry and the OVIDE group (IFREMER)

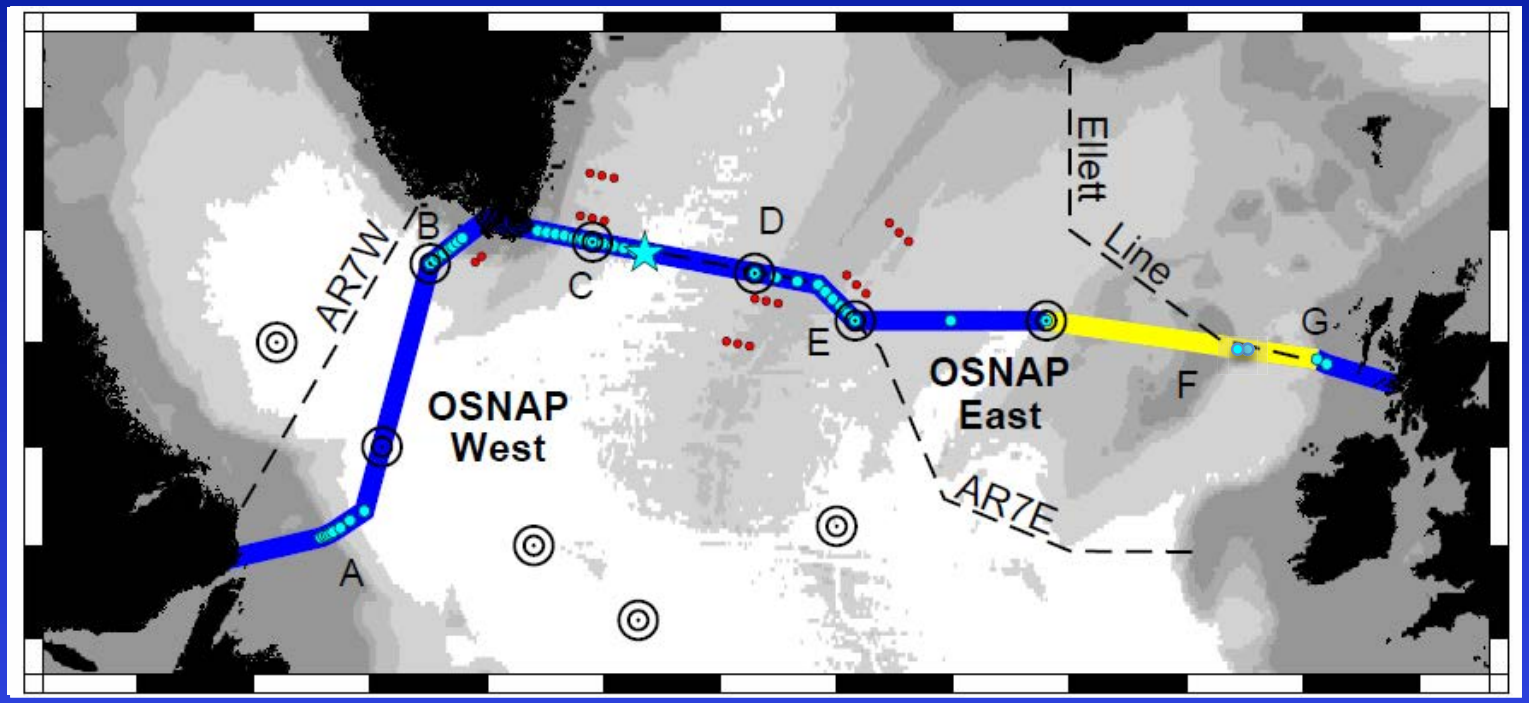
China: Dexing Wu and Xiaopei Lin (OUC)

Overall design: A transoceanic line in the subpolar North Atlantic that can capture the net transport of the overflow waters from the Nordic Seas, as well as that from the Labrador Sea. Designed to complement the RAPID array and EU NACLIM observations, thereby providing measurements to evaluate intergyre connectivity within the North Atlantic.

The specific objectives of OSNAP are to:

1. Relate AMOC variability to deep water mass variability and basin-scale wind forcing.
2. Assess overturning sensitivity to variations in Arctic freshwater input
3. Determine the pathways and transports of overflow waters in the NASPG to investigate the connectivity of the deep boundary current system.
4. Determine the nature and degree of the overflow-subpolar-subtropical AMOC connectivity.
5. Determine from new OSNAP measurements the configuration of an optimally efficient long-term AMOC monitoring system in the NASPG.

OSNAP overall goal: To quantify the large-scale, low-frequency, full water-column net fluxes of mass, heat and fresh water associated with the meridional overturning circulation in the subpolar North Atlantic.



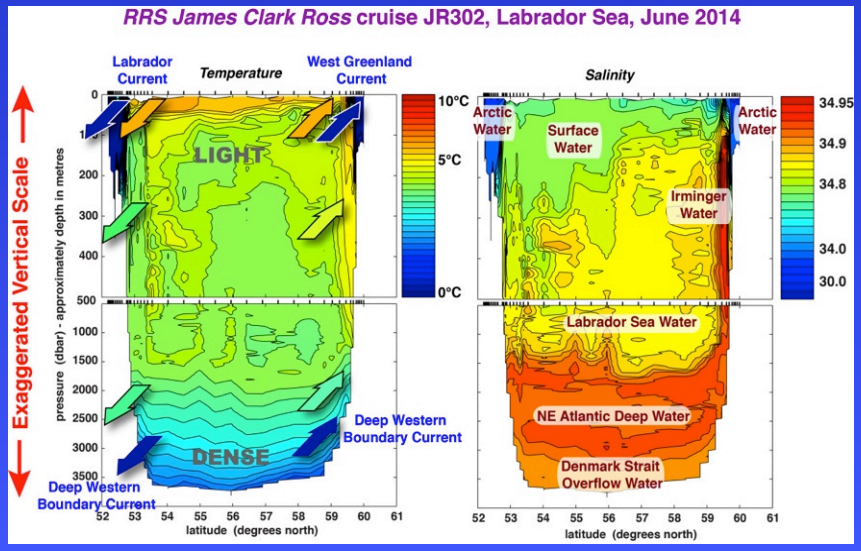
(A) German 53°N western boundary array and Canadian shelfbreak array;
(B) US West Greenland boundary array;
(C) US/UK East Greenland boundary array;
(D) Netherlands western Mid-Atlantic Ridge array;
(E) US eastern Mid-Atlantic Ridge array;
(F) UK glider survey over the Hatton-Rockall Bank and Rockall Trough;
(G) UK Rockall Trough current array.
Red dots: US float launch sites.
Blue star: US OOI Irminger Sea global node.
Black concentric circles: US sound sources.

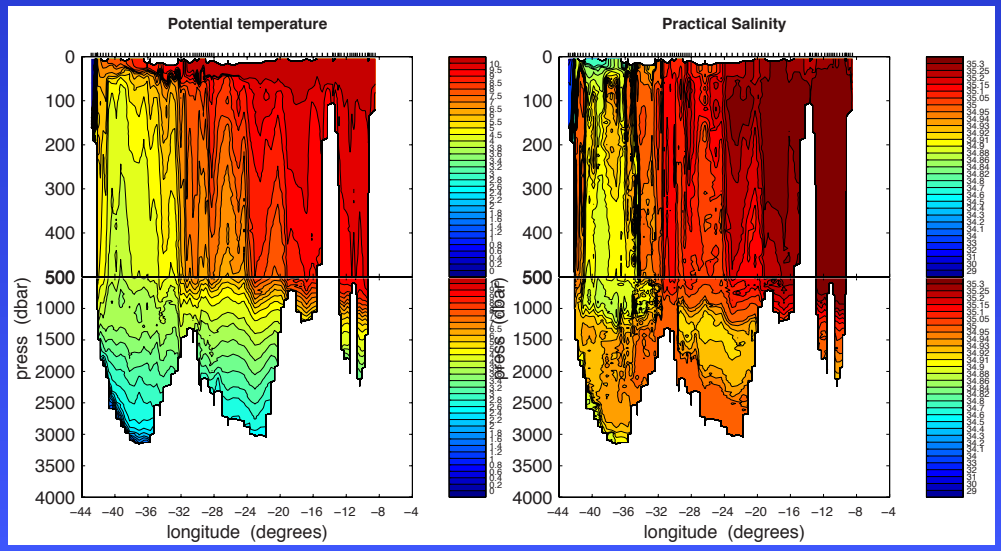
*To be added in 2015: Glider survey across the Iceland basin by OUC (China)

OSNAP Cruises (summer 2014)

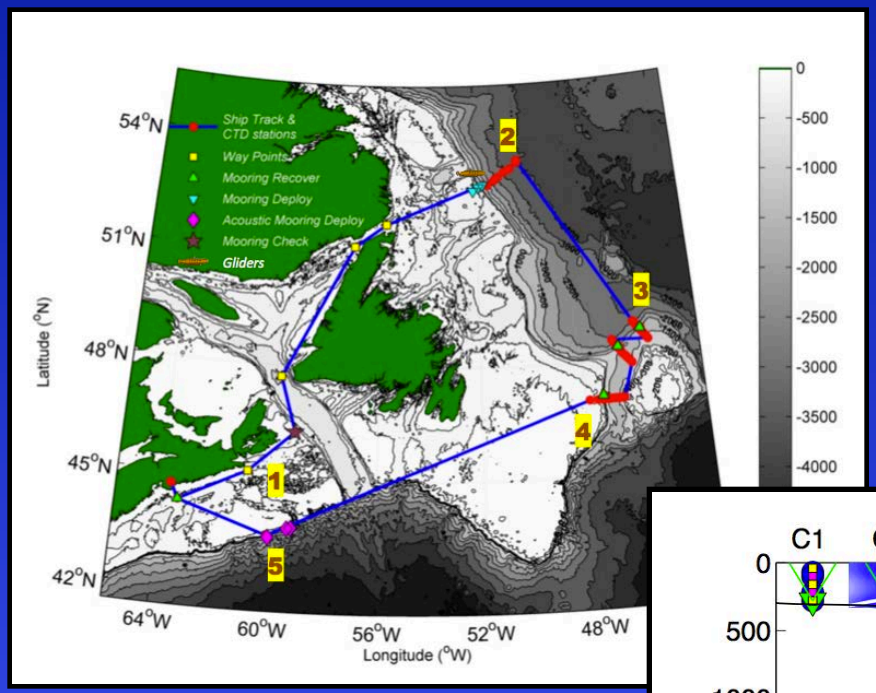
- **OSNAP 1**: RRS James Clark Ross (June 6 – July 21, 2014)
  - **Chief scientists: Brian King and Penny Holliday (NOC)**
  - **Purpose: Hydrographic section across OSNAP West and East: temperature, salinity, oxygen, nutrients, carbon and CFCs.**
- **OSNAP 2**: R/V Knorr (June 19 –July 3, 2014)
  - **Chief scientist: Brian Guest (WHOI)**
  - **Purpose: Deployment of sound sources and RAFOS floats**
- **OSNAP 3**: R/V CCGS Hudson (June 30 – July 15, 2014)
  - **Chief scientist: Blair Greenan**
  - **Purpose: Mooring and glider deployments/hydrography on the Labrador shelf**
- **OSNAP 4**: R/V Knorr (July 6 – 31, 2014)
  - **Chief scientist: Bill Johns (U. of Miami)**
  - **Purpose: Deployment of moorings, sound sources and RAFOS floats along OSNAP East**
- **OSNAP 5**: R/V Knorr (August 5 – September 1, 2014)
  - **Chief scientist: Bob Pickart (WHOI)**
  - **Purpose: Deployment of moorings, sound sources and RAFOS floats along OSNAP West/East (Cape Farewell array + Labrador Sea eastern boundary array)**
- **OSNAP 6**: FRV Thalassa (August 6 – 24, 2014)
  - **Chief scientist: Johannes Karstensen (GEOMAR)**
  - **Purpose: Deployment of moorings and sound sources on OSNAP West (Labrador Sea western boundary array)**

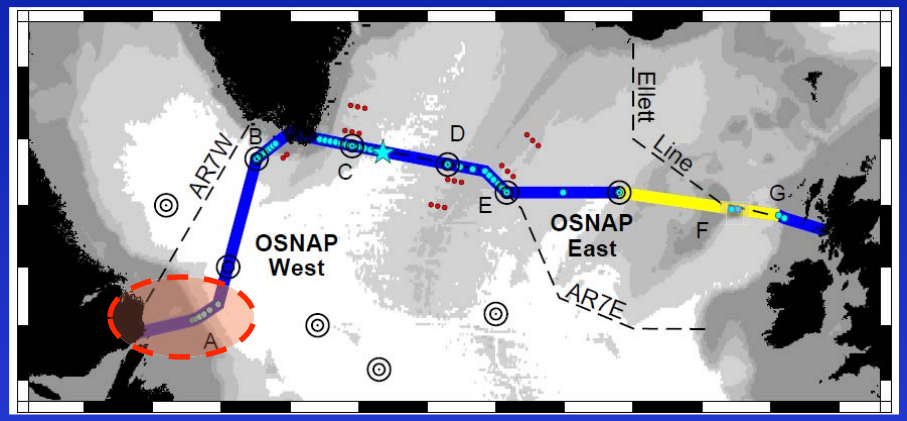
RRS James Clark Ross (June 6 – July 21, 2014)

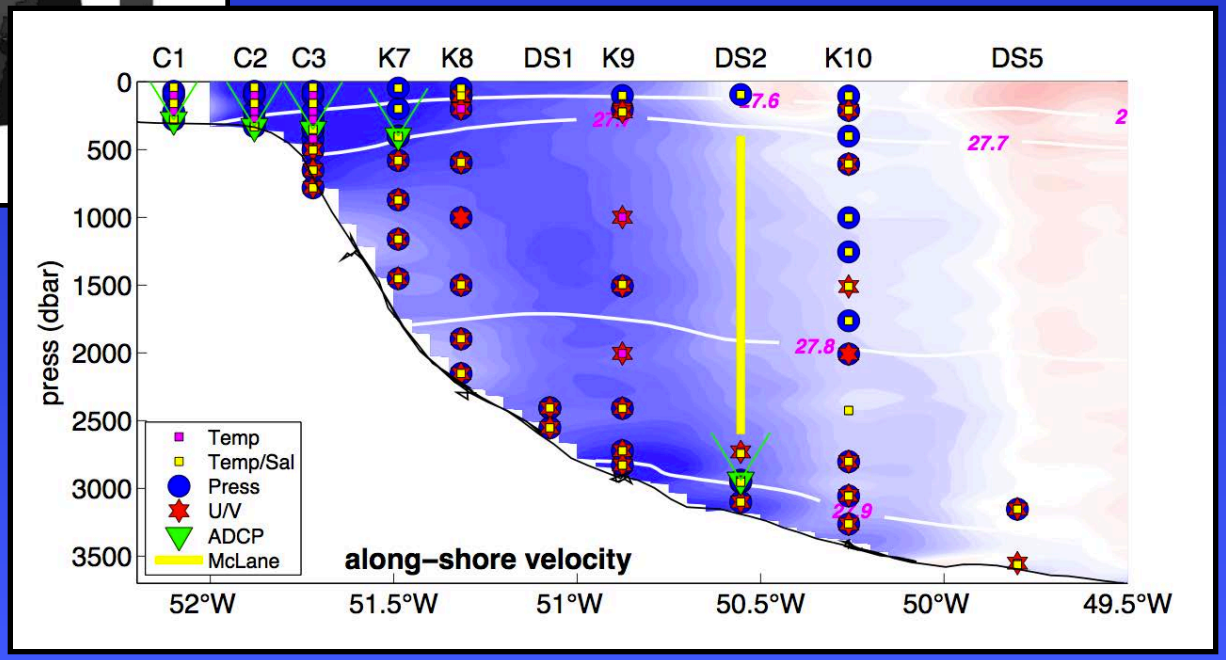




R/V CCGS Hudson (June 30 – July 15, 2014)
FRV Thalassa (August 6 – 24, 2014)

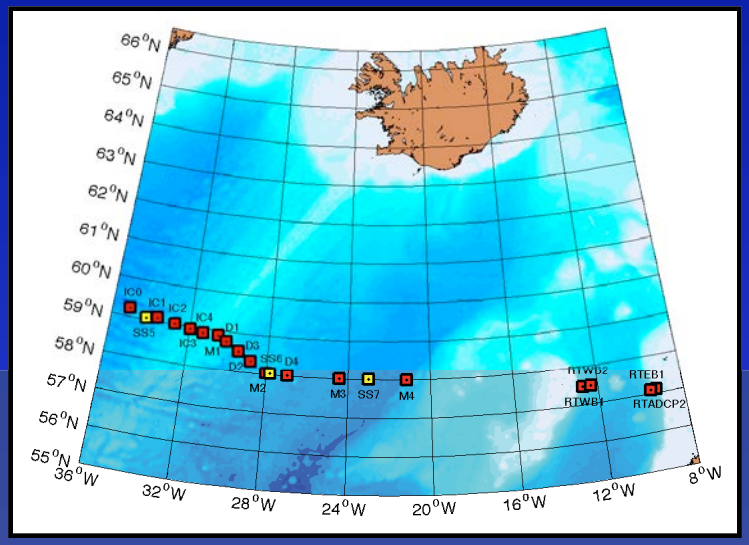


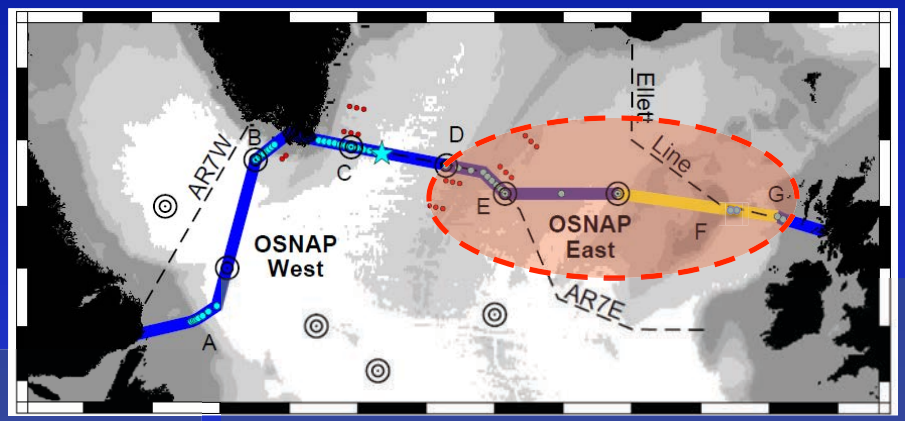


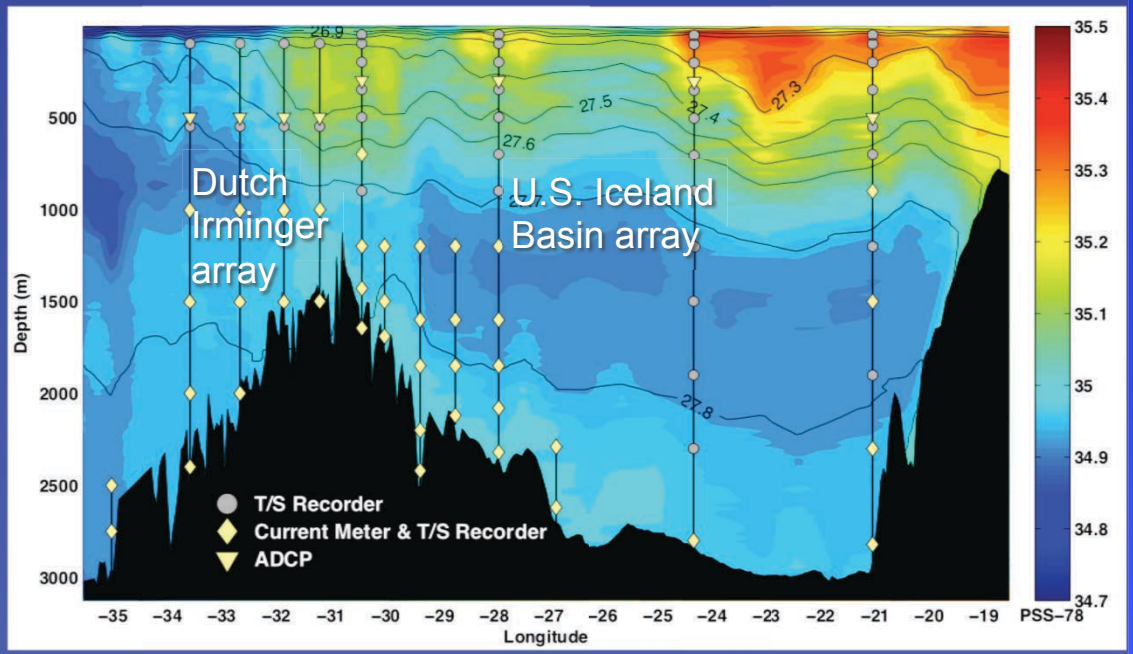


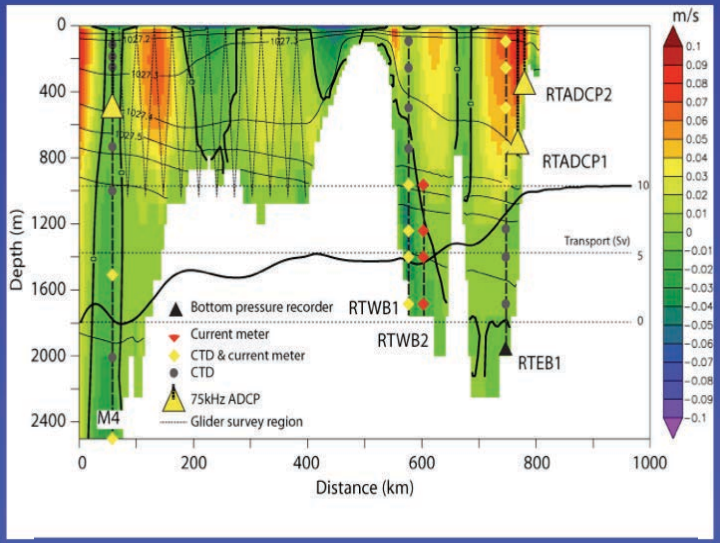
Canadian shelf and Labrador Sea western boundary array

R/V Knorr (July 6 – 31, 2014)



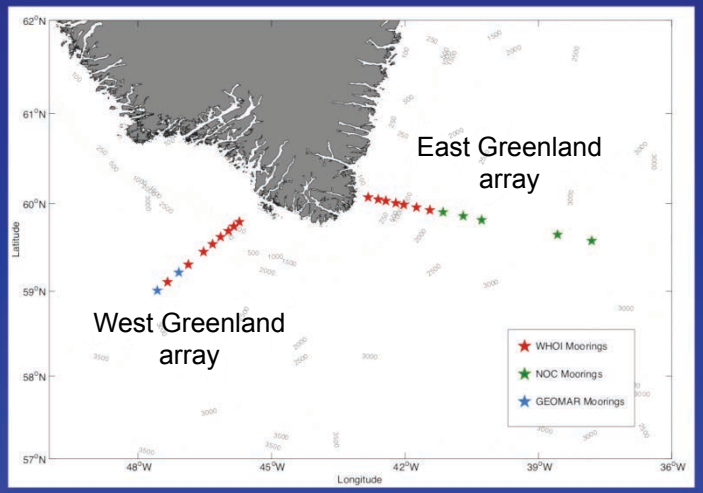


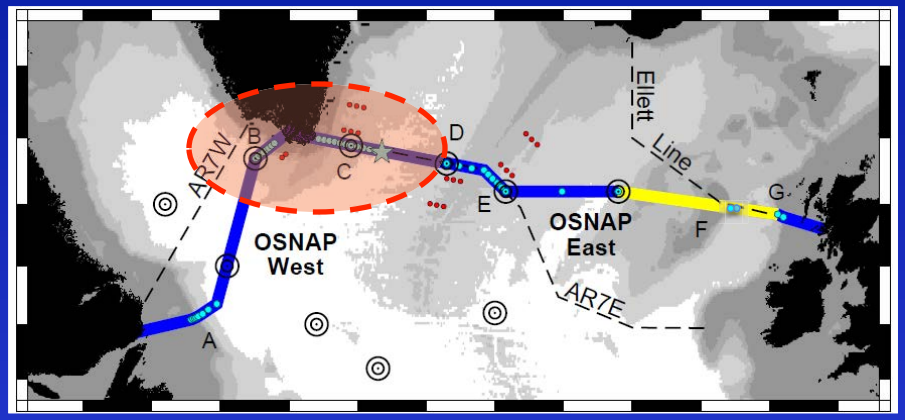


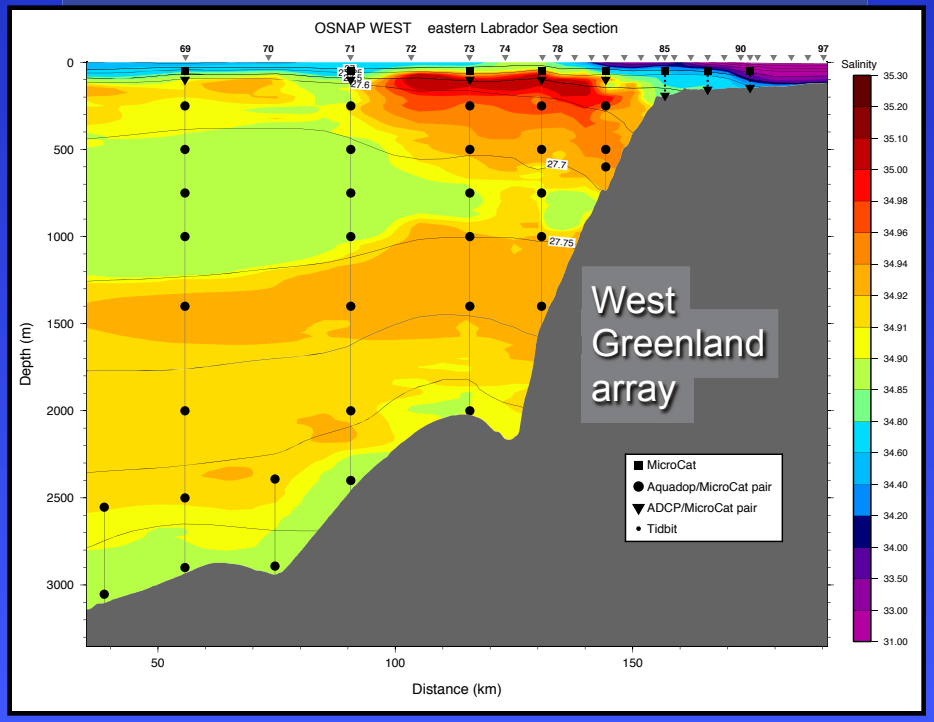


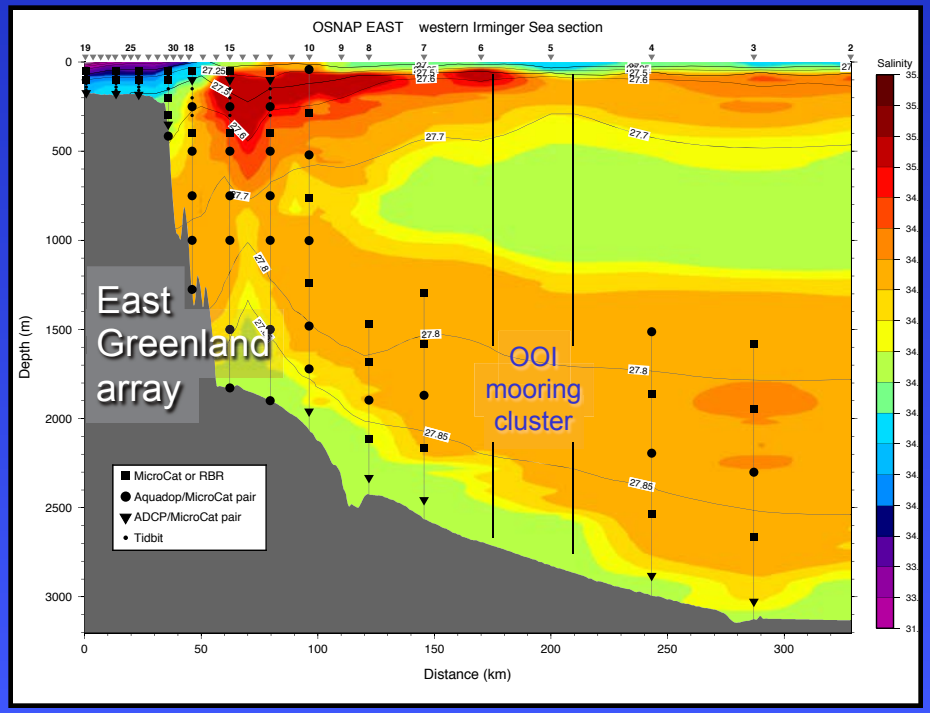
Scottish Rockall array and Gliders

R/V Knorr (August 5 – September 1, 2014)

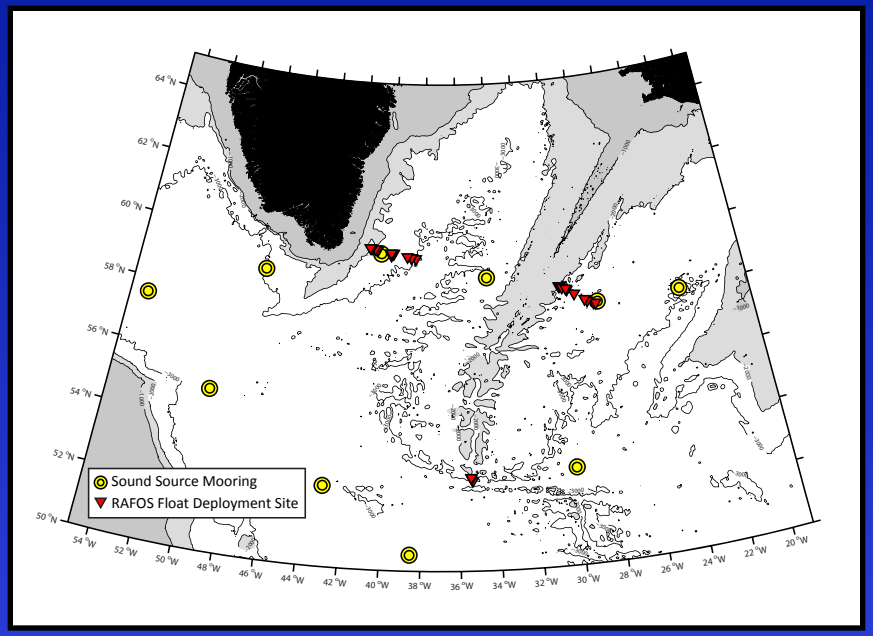


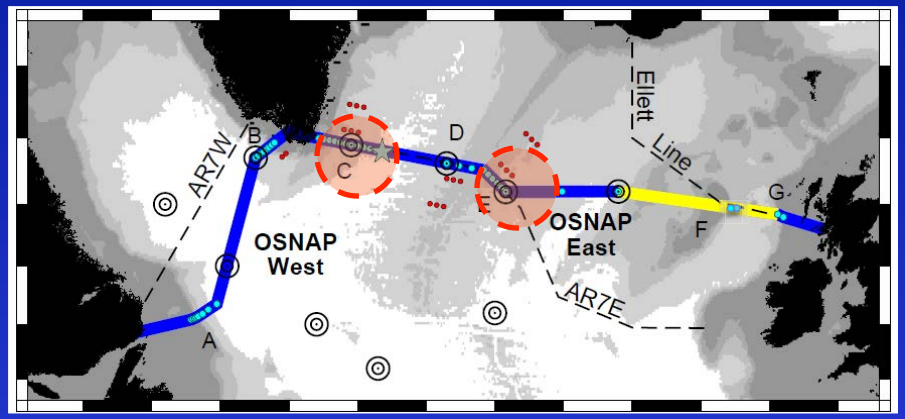


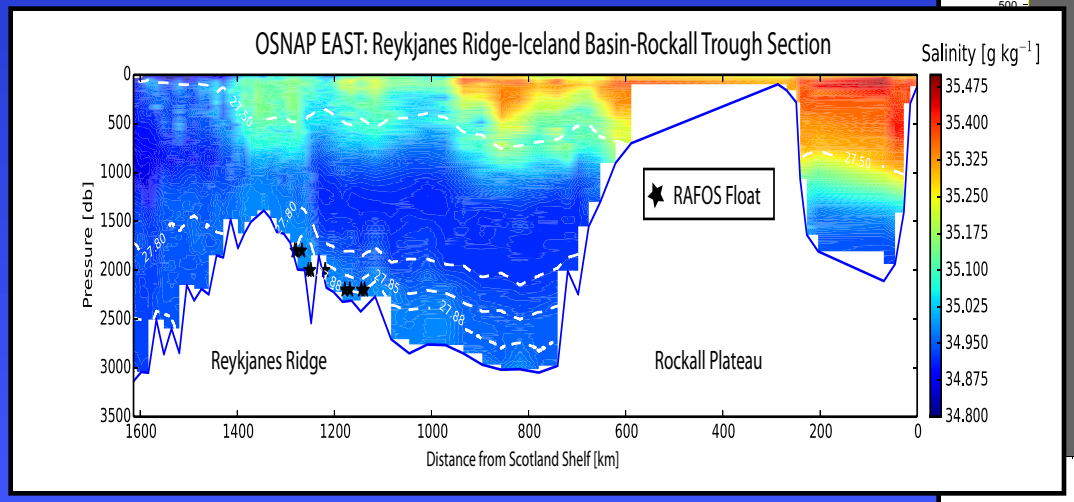


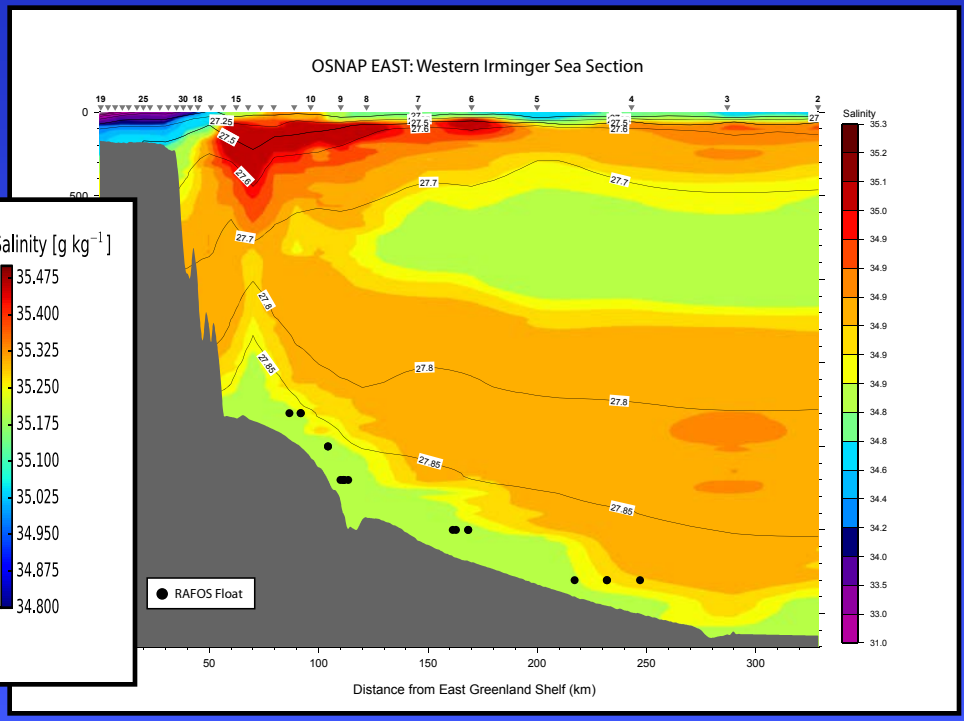


OSNAP Floats (120 floats total; 40/yr during first 3 years)



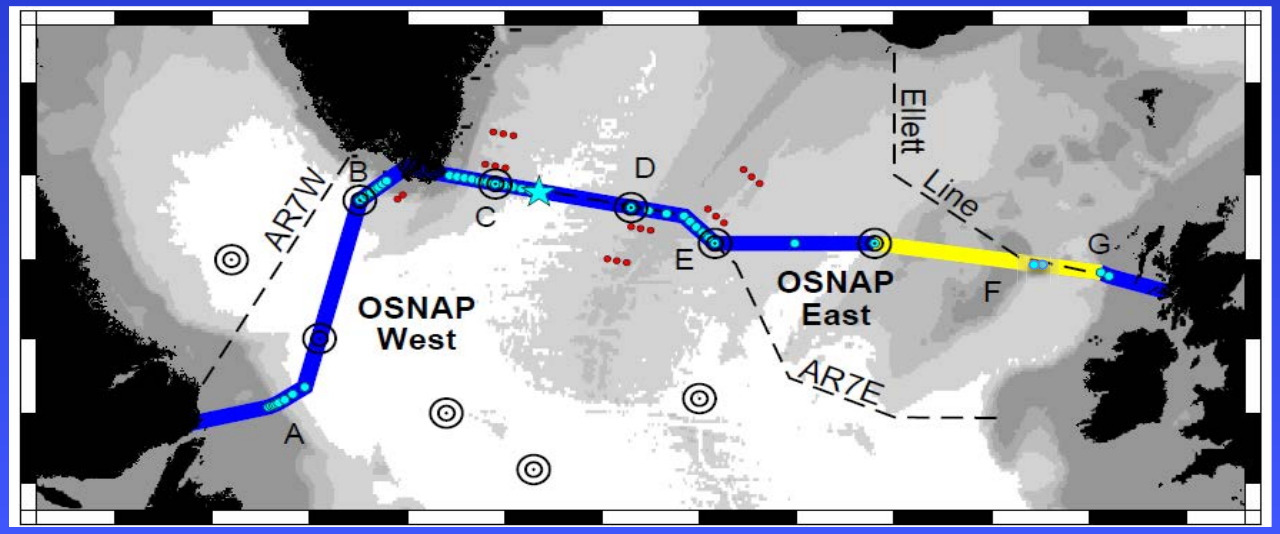




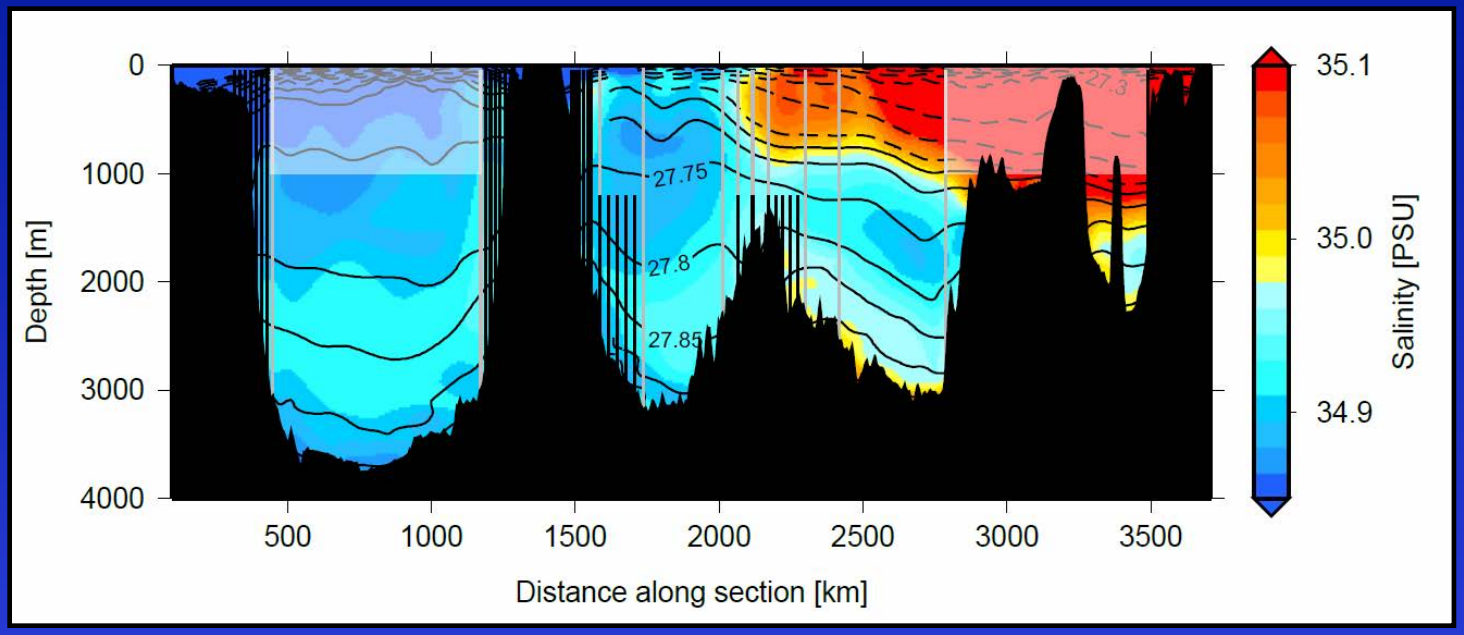


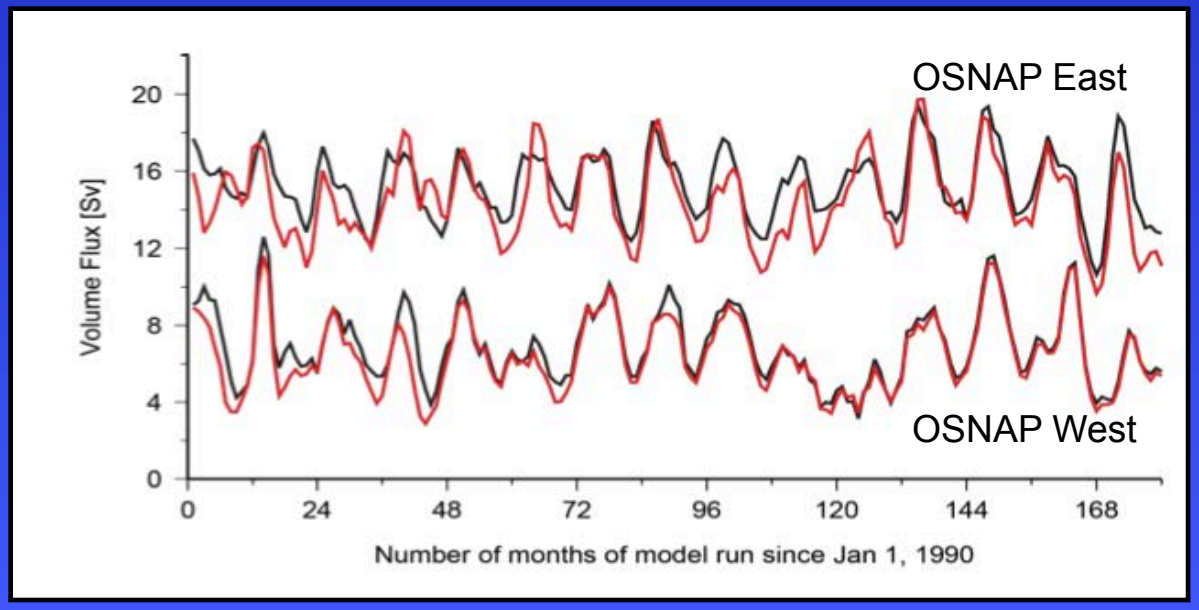
Data Recovery Schedule

- Summer 2015: OSNAP East (Rockall, Iceland Basin, Irminger, and U.K. Cape Farewell array) + Canadian shelf array recovered and redeployed
- Summer 2016: All arrays recovered and redeployed
- Summer 2018: All arrays recovered
- Floats: 40 mostly 3-year missions, first substantial data returns in 2017.
- Gliders: Near-real time; OUC gliders to be added in 2015



Testing the array with Observing System Experiments: FLAME model





Overturning in density coordinates (Sv):

Red = model truth

Black = OSE

Summary

- Given the breadth of expected impacts from AMOC variability, the international community has launched a new observational program, OSNAP, in the summer of 2014 to measure the overturning in the subpolar North Atlantic.

- OSNAP is an international program, with 7 participating countries.

- Together, OSNAP, NACLIM and the RAPID 26°N observational systems will provide a means to evaluate intergyre connectivity and to establish a long-term comprehensive observing system in the North Atlantic.

- Deployment of the OSNAP observing system is nearly complete.

- For more information on OSNAP, see: www.o-snap.org (cruise plans, cruise reports and blogs, news and events, etc.)

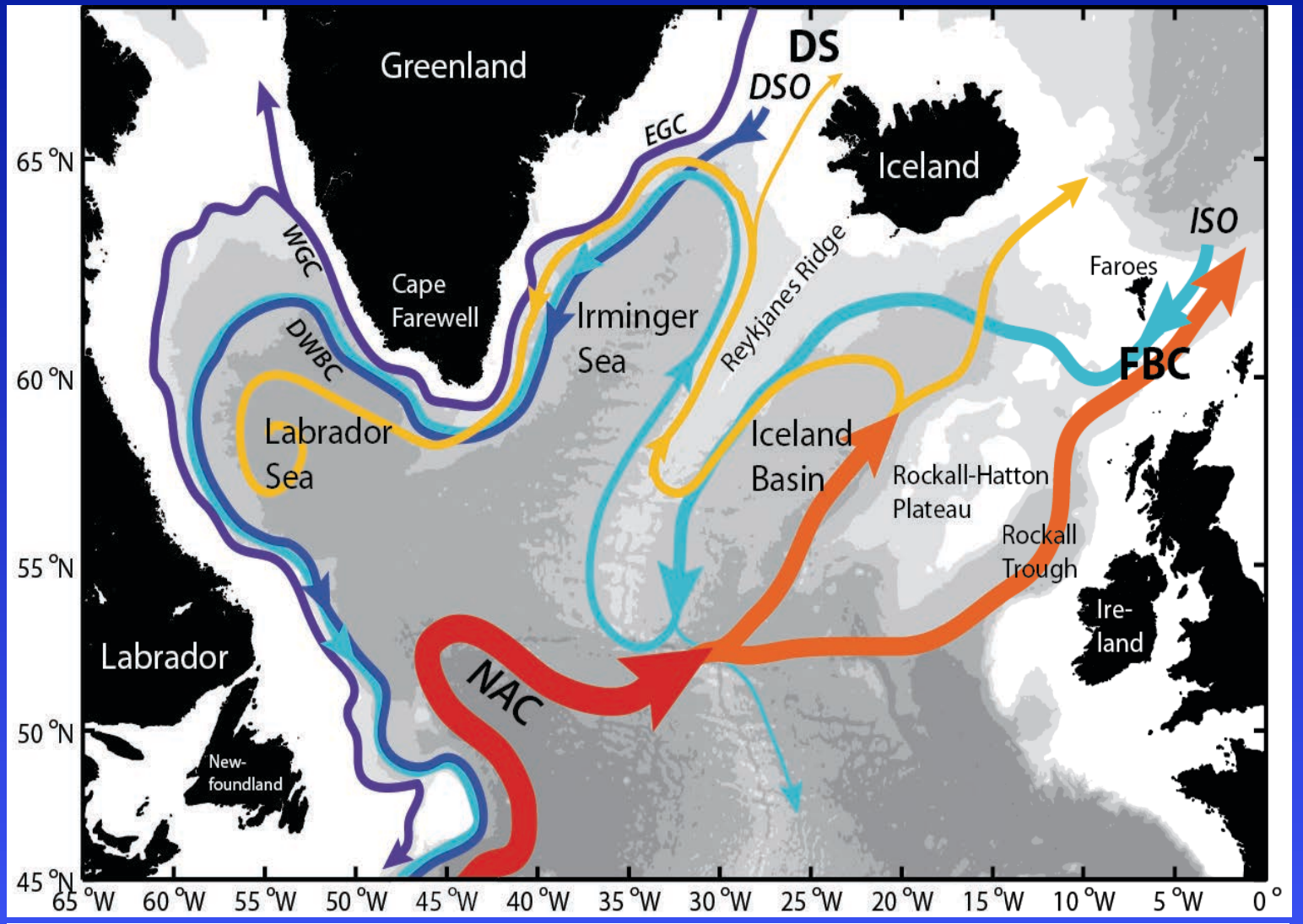
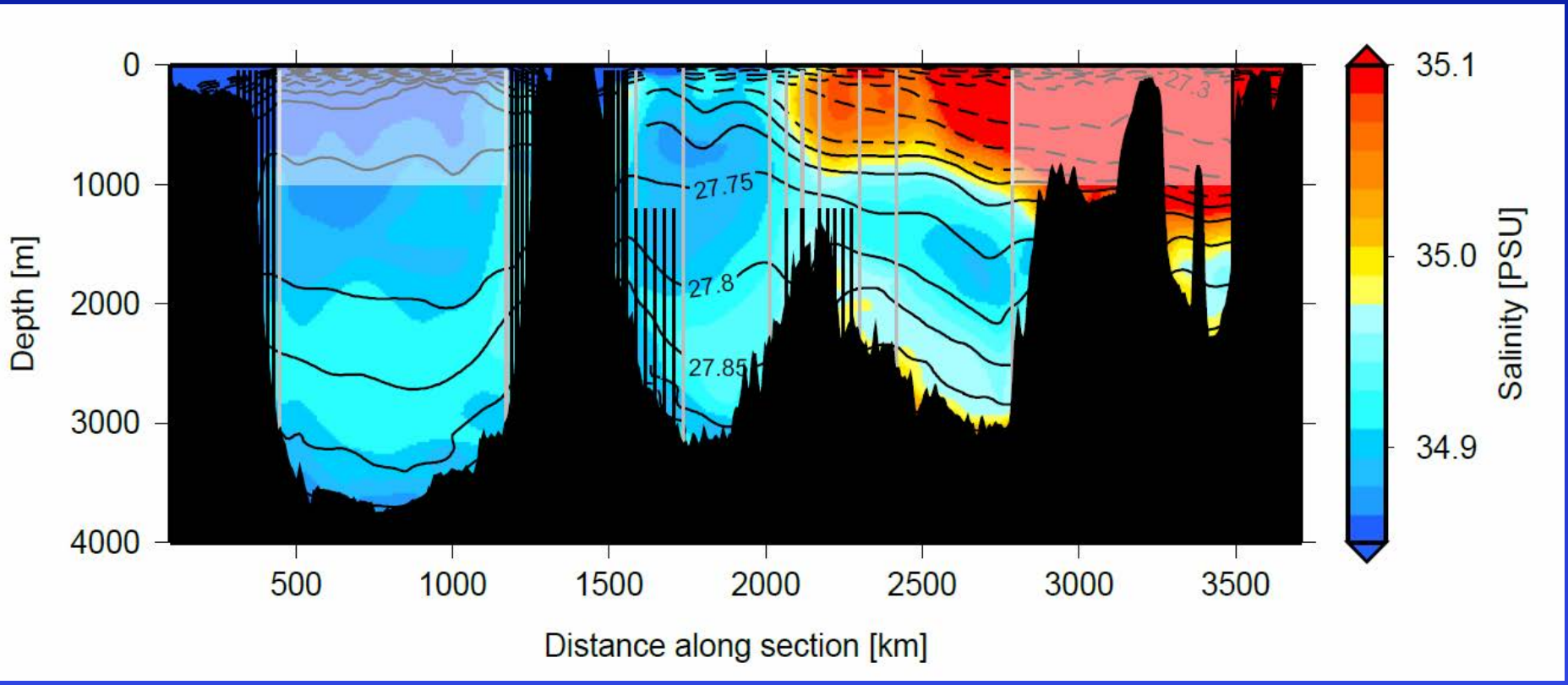


Figure 2. Schematic of the major warm (red to yellow) and cold (blue to purple) water pathways in the North Atlantic subpolar gyre. Acronyms not in the text: Denmark Strait (DS); Faroe Bank Channel (FBC); East and West Greenland Currents (EGC, WGC); North Atlantic Current (NAC); Charlie Gibbs Fracture Zone (CGFZ).

OSNAP array superposed on climatological salinity along the OSNAP West (leftmost basin) and East lines.



The AMOC is reconstructed by directly measuring the currents at the boundaries and over the flanks of the Reykjanes Ridge, and through the use of moored T/S sensors and gliders to estimate the interior geostrophic velocities. Black moorings indicate where the velocity field is directly sampled. Gray moorings double as direct velocity measures and endpoints for the geostrophic regions.

OSNAP East objectives:

1. Quantify the overturning circulation of the eastern NASPG on monthly to interannual timescales, in depth and in density coordinates.

2. Determine the relationship between overturning strength and the transport of Denmark Strait and Iceland-Scotland overflow waters.

3. Determine the net inflow of subtropical waters across the OSNAP East line and the associated heat and freshwater fluxes to the eastern NASPG.

OSNAP West objectives:

1. Quantify the overturning circulation of the Labrador Sea and the associated heat and freshwater fluxes on monthly to interannual timescales, in depth and in density coordinates.

2. Determine the relationship between overturning strength and the extent of deep convection in the interior Labrador basin.

3. Quantify the horizontal circulation cell in the Labrador Sea and characterize the evolution of deep and intermediate waters transiting from Cape Farewell to the exit of the Labrador Sea.