EQUIPEX NAOS
WP5 : Deep oxygen floats in the North-Atlantic

Virginie Thierry

Guillaume Maze, Herlé Mercier, Cécile Cabanes, Virginie Racapé

Laboratoire d'Océanographie Physique et Spatiale

UMR 6523 CNRS / IFREMER / IRD / UBO–IUEM

WP5: Scientific and technological objectives

- **Deployment of 23 Deep-Arvor floats with oxygen sensor in the North-Atlantic Ocean**

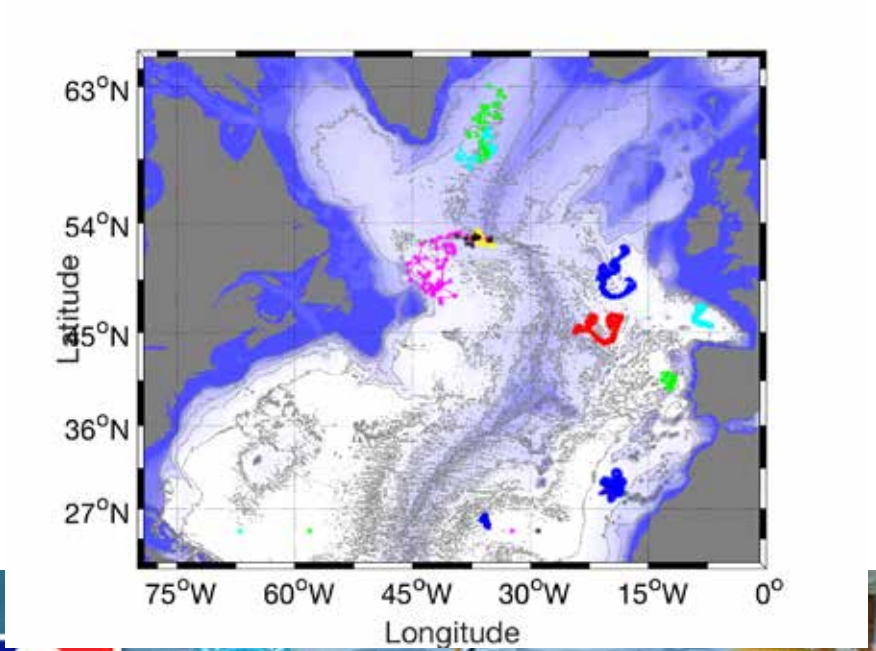
- **Implement a pilot experiment for O2 and deep data**
  - Deploy Argo-O2 floats and Deep-Arvor floats in the North-Atlantic Ocean
  - Implement the corresponding data stream at international level
  - Prepare the future international Deep-Argo and Argo-O2 array

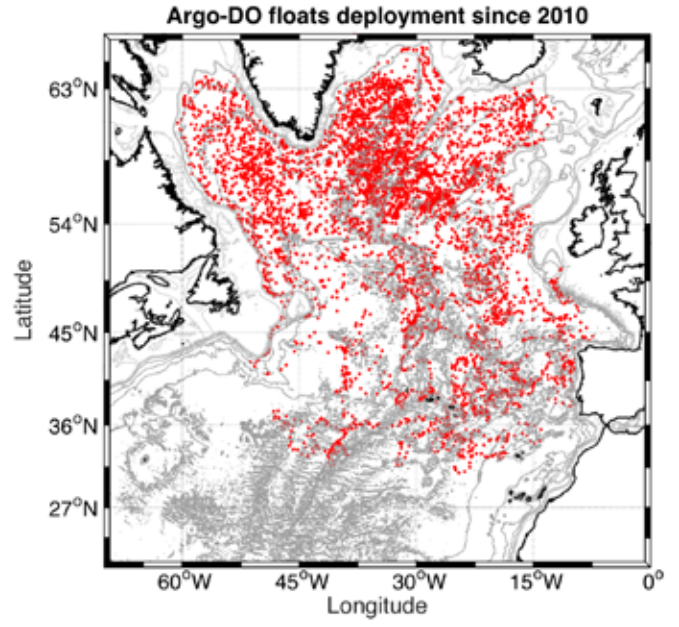
- **Technological objective:** Demonstrate the capacity of the Deep-Arvor float at acquiring deep (below 2000m depth) and oxygen data of high-quality

- **Scientific objective** : Investigate deep convection and water mass ventilation in order to investigate the input and propagation of climatic anomalies within the ocean interior

Pilot experiment for O2 and Deep-Argo data

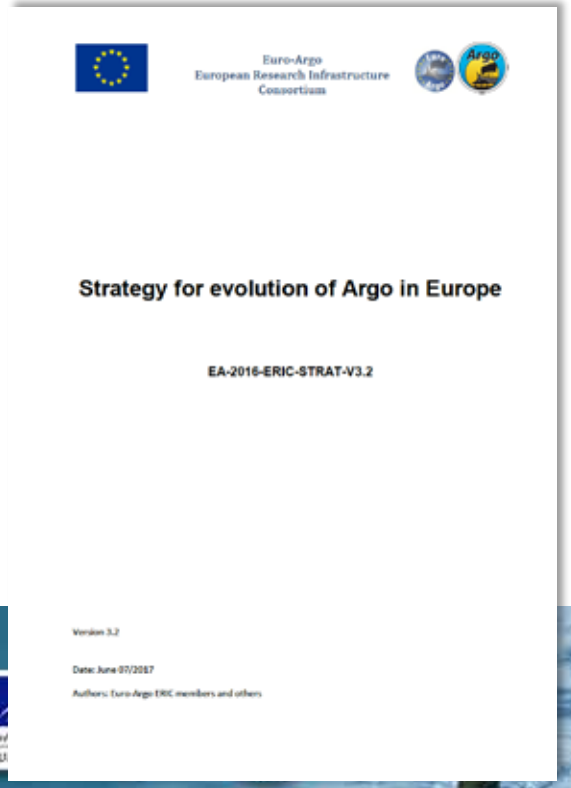
- **Float deployment**
  - 10 Deep-Arvor floats with O2 sensor deployed in the North-Atlantic Ocean
  - More floats will be deployed in the coming years (remaining NAOS floats and floats funded by CPER Euro-Argo over 2018-2021)
  - Those data complement Argo-O2 floats deployed in the North-Atlantic since 2010

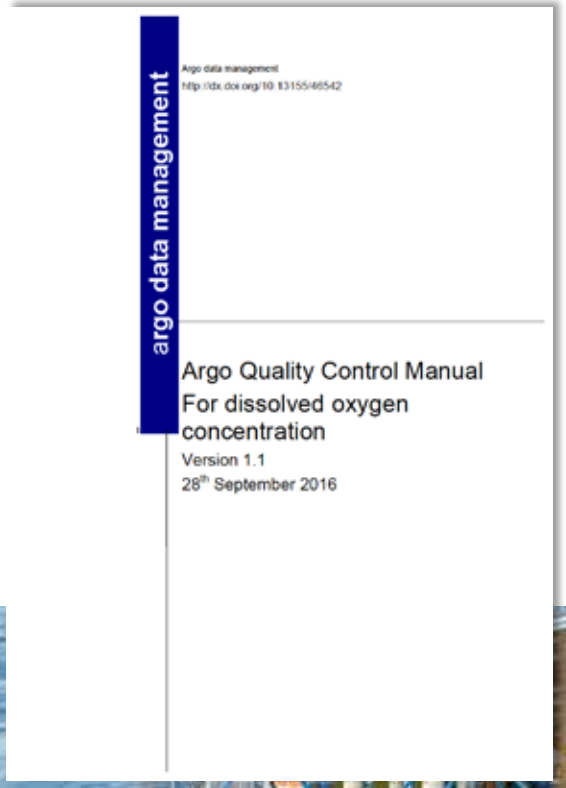


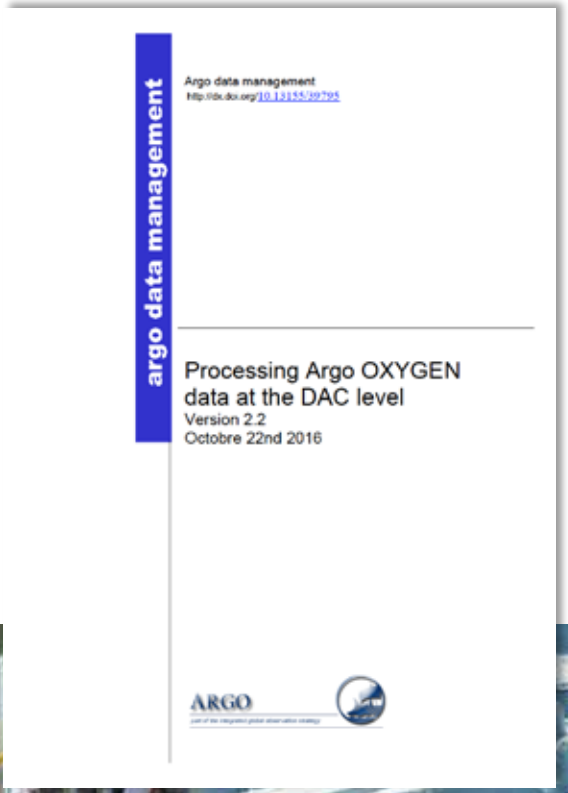


Pilot experiment for O2 and Deep-Argo data

- **Data stream and deployment strategy**
  - We established the the data management procedure for O2 data from decoding to qualification
  - We contribute to establish the European strategy regarding the Deep-Argo and Argo-O2 arrays in agreement with European partners and the international Argo program

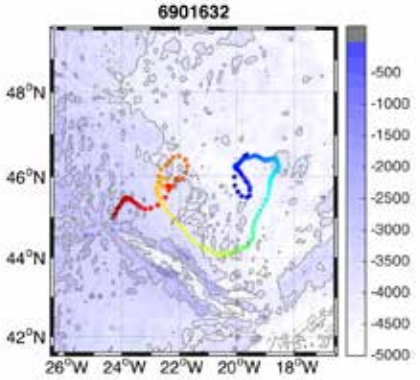


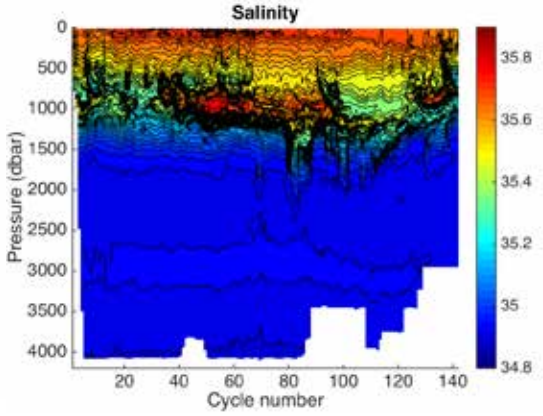


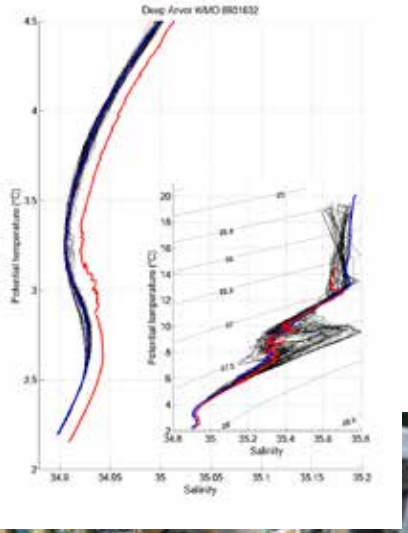


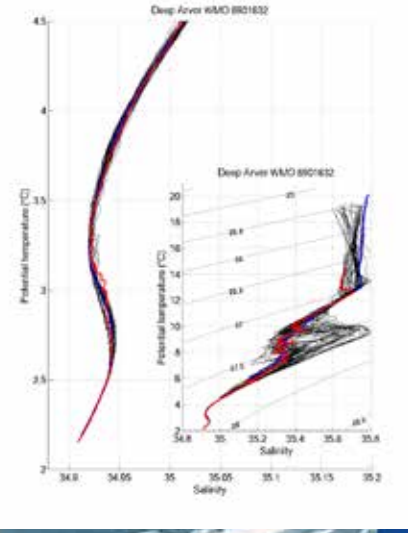
Demonstrate the capacity of the Deep-Arvor float at acquiring deep (below 2000m depth) and oxygen data of high-quality

- The Deep-Arvor float is able to achieve more than 140 cycles
- Owing to the measurements below 2000m, the Deep-Arvor floats revealed that a fresh bias was present in the classical Argo floats. Such bias is easily correctable and has been resolved by enhanced quality checks before deployment and a modification of the storage procedure



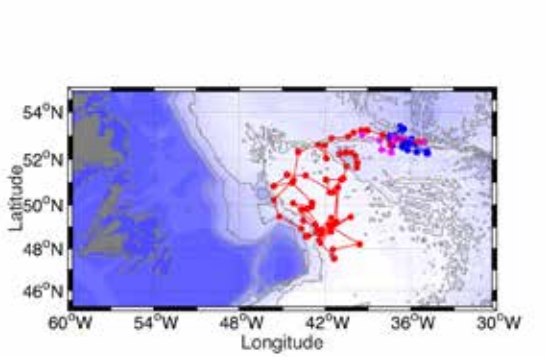


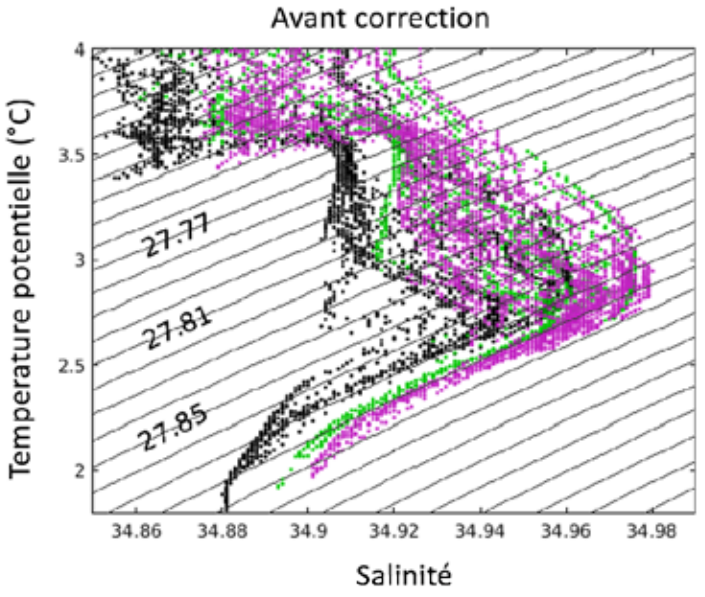


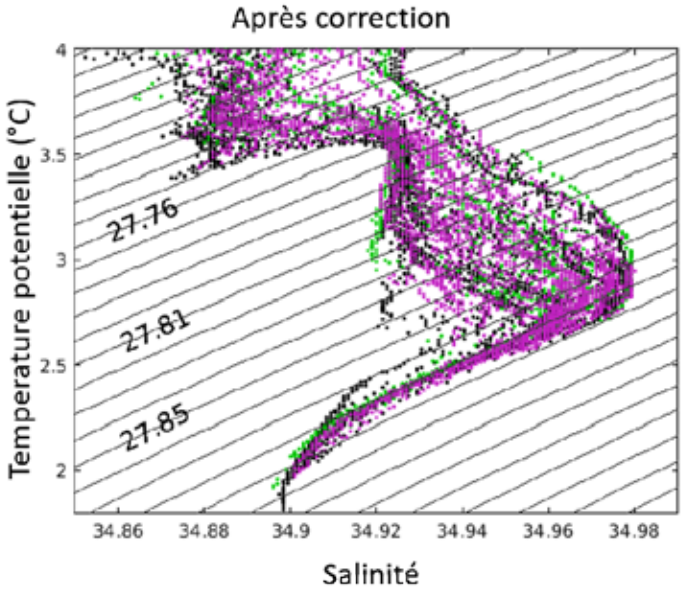


Demonstrate the capacity of the Deep-Arvor float at acquiring deep (below 2000m depth) and oxygen data of high-quality

- The Deep-Arvor float is able to achieve more than 140 cycles
- Owing to the measurements below 2000m, the Deep-Arvor floats revealed that a fresh bias was present in the classical Argo floats. Such bias is easily correctable and has been resolved by enhanced quality checks before deployment and a modification of the storage procedure

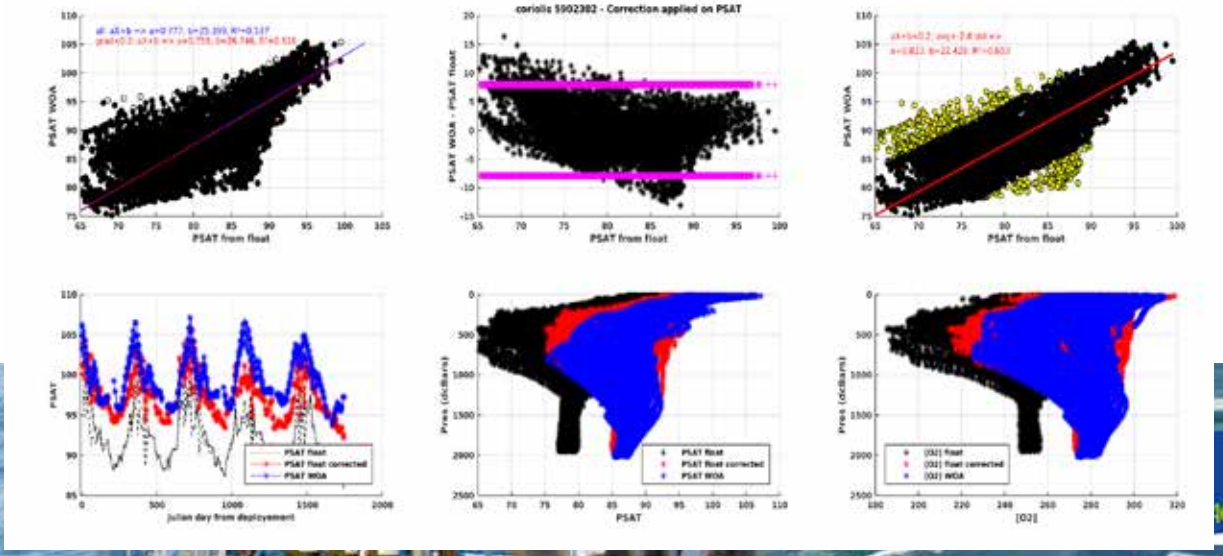






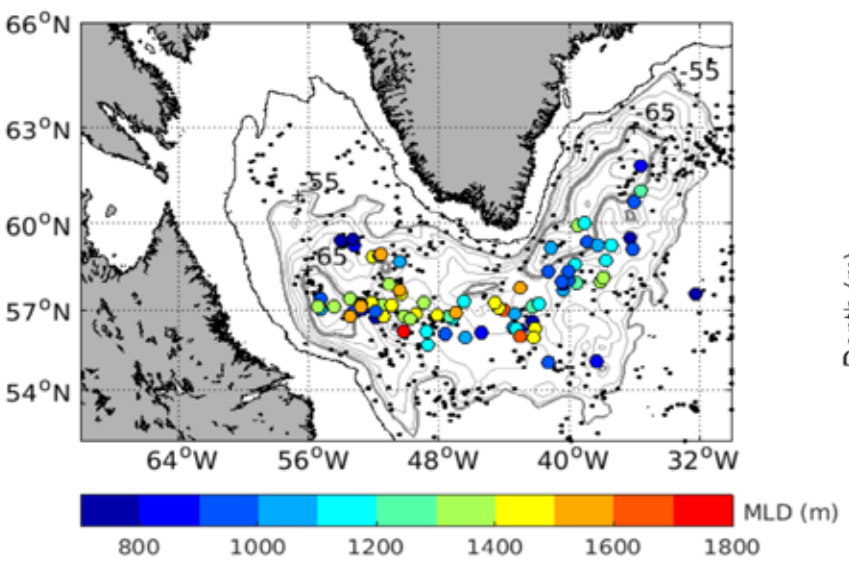
Demonstrate the capacity of the Deep-Arvor float at acquiring deep (below 2000m depth) and oxygen data of high-quality

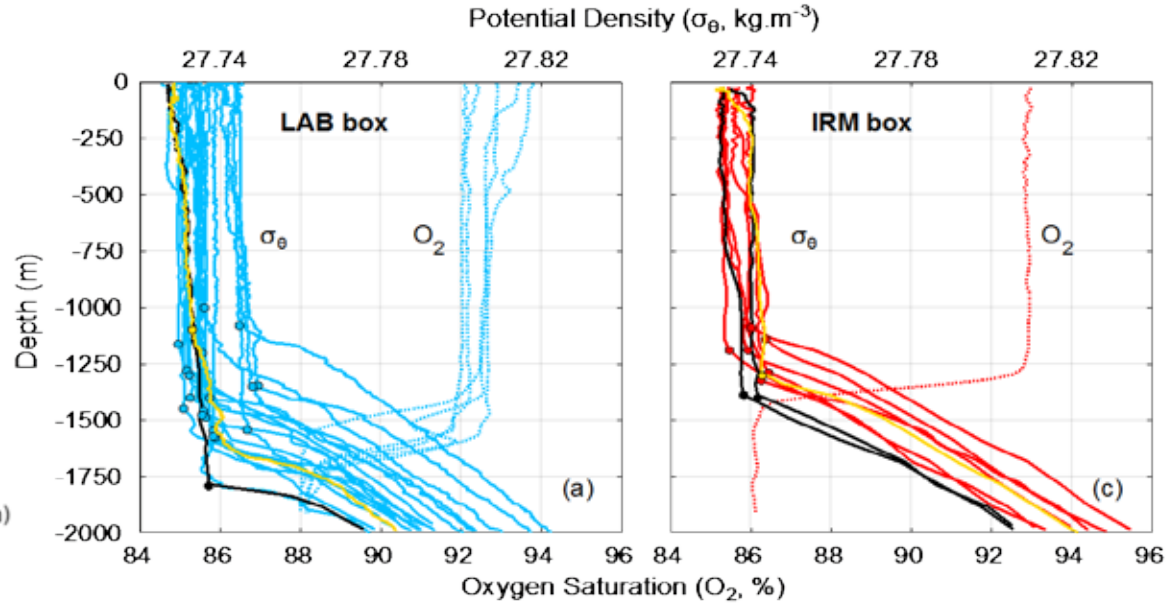
- **We developed the LOCODOX tool to correct oxygen sensor bias and drift and to generate DM files in the Argo format (subcontracting with Altran)**
  - Correction based on WOA or on a reference profile
  - Adjusted data from 32 floats were submitted to Coriolis and are now available to the scientific community
  - The tool is still under development (2,5 months /year) : implementation of the correction based on in air measurements



Scientific analyses

- **Investigate deep convection in the Irminger Sea and document an exceptionnal deep convection event that occured at basin scale during winter 2014-2015: PhD thesis A. Piron (Piron et al, 2016, 2017)**





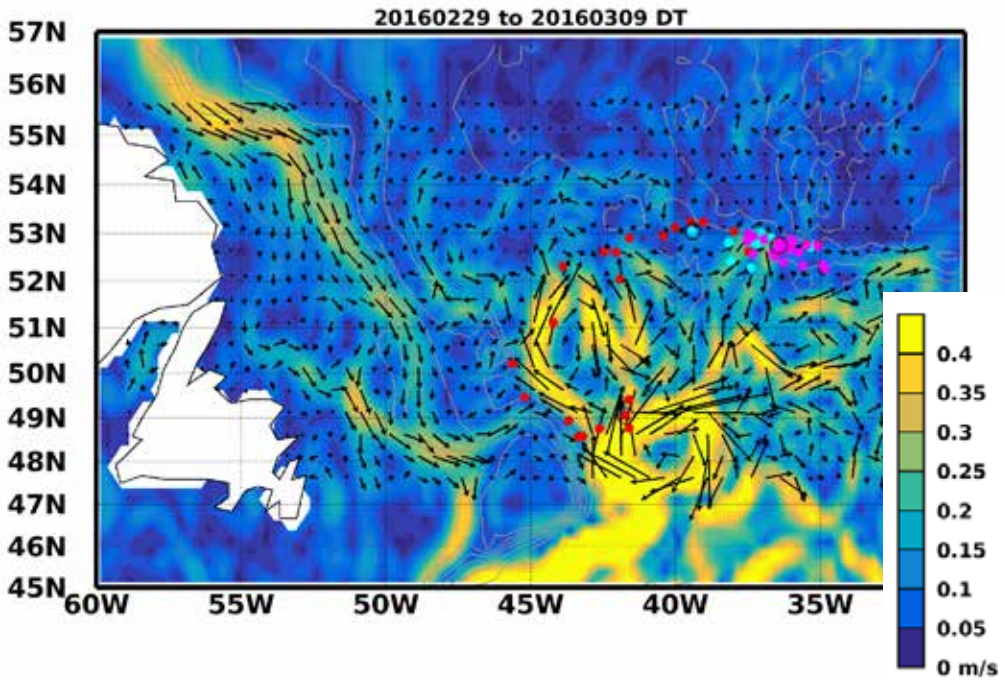
Due to exceptionnal winter heat loss, the mixed layer observed in March 2015 in the Imringer Sea are the deepest mixed layer ever observed in this basin.

Scientific analyses

Investigate new pathways for the deep water masses as revealed by Deep-Arvor float trajectory and their connection with the surface circulation; post-doc V. Racapé

Surface geostrophic velocity (m/s)

(AVISO+, resolution averaged on one Deep-Argo cycle)



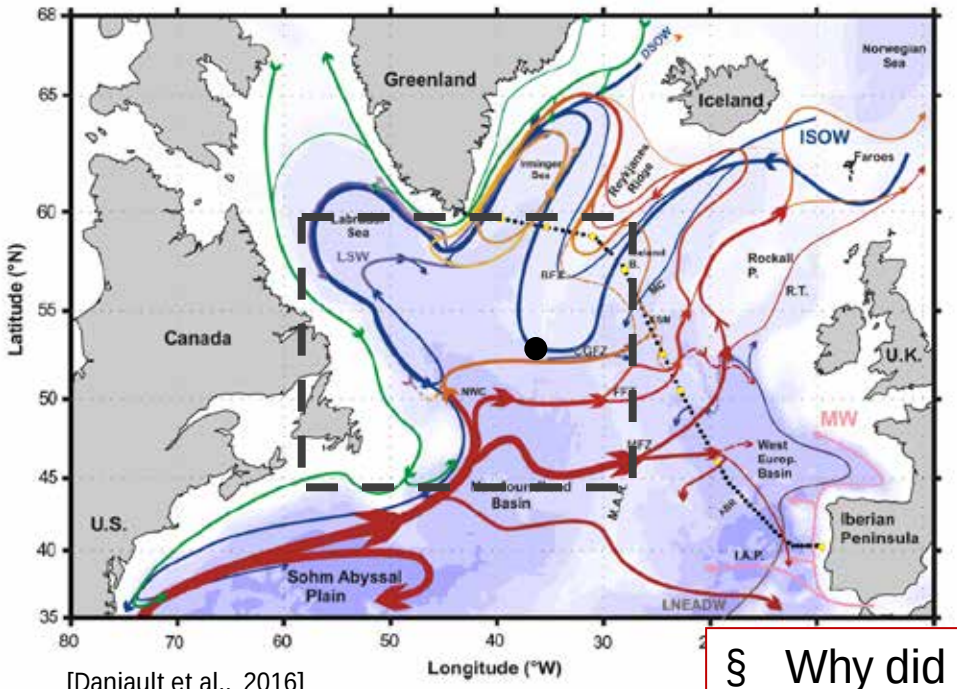
Deep-Argo floats

- 3 deep-Argo floats deployed in Jully 2015 (RREX cruise)
- 1 cycle = 10 days
- Parking depth = 2750 dbar during 9 days (to sample ISOW)
- T, S, O_2, GPS position (Iridium)

Scientific analyses

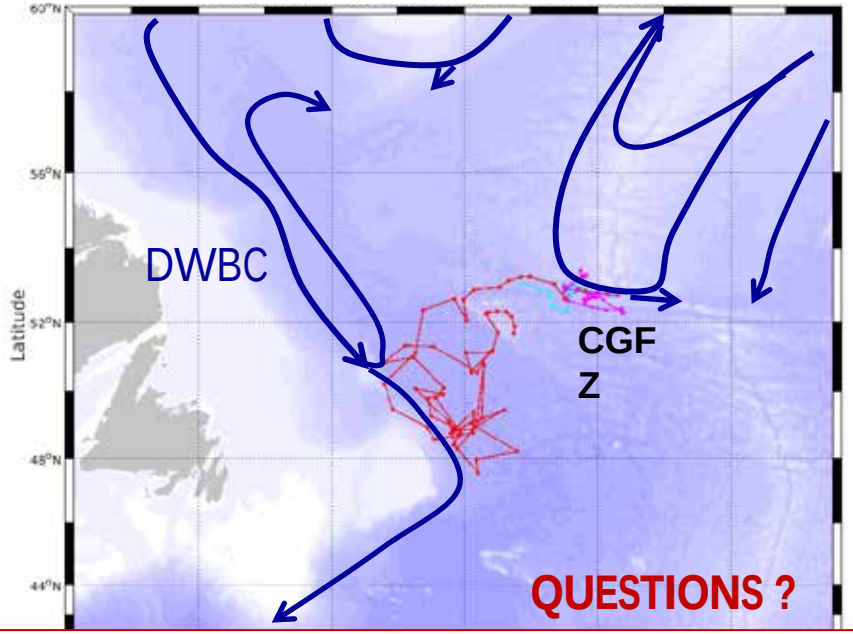
Dynamical context

Large scale circulation scheme in the North Atlantic subpolar gyre



[Daniault et al., 2016]

Deep circulation σ_0 > 27.8

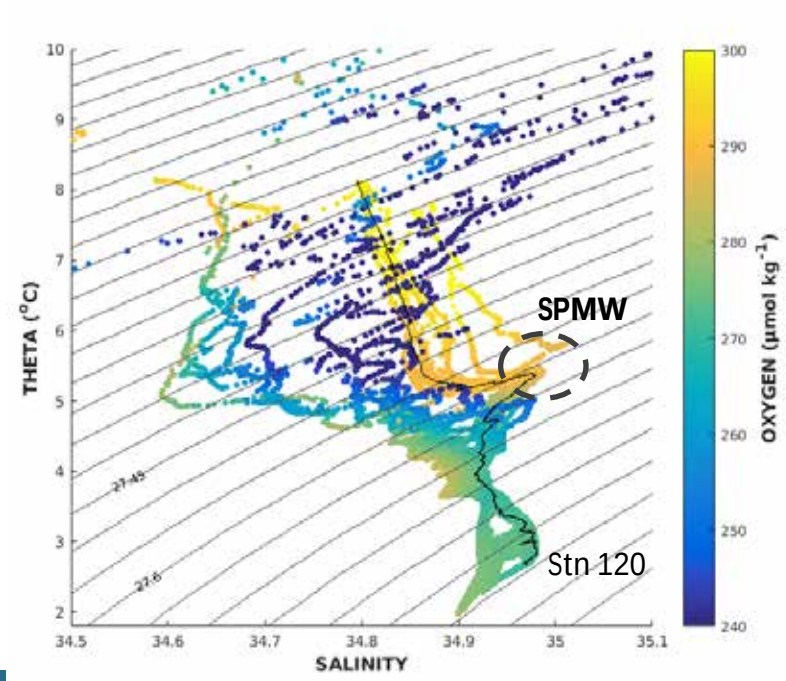


- Why did none of the floats reach the Irminger basin?
- Why did they move apart at 37 ° W?
- Did the red float sample the DWBC ?

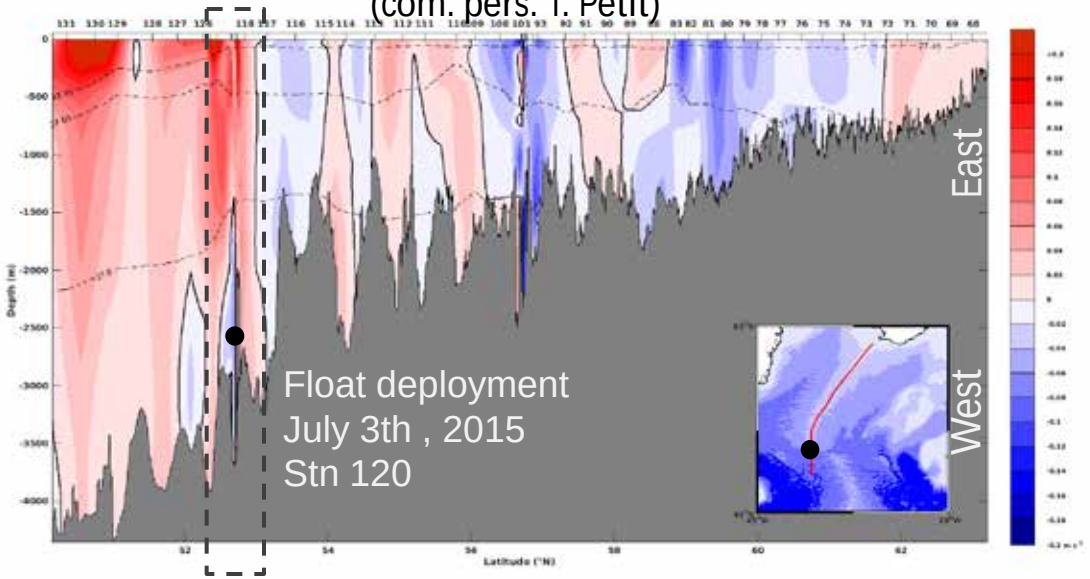
Scientific analyses

Dynamical conditions during float deployment

Theta – salinity – O_2 diagram for RREX stations 114 to 131

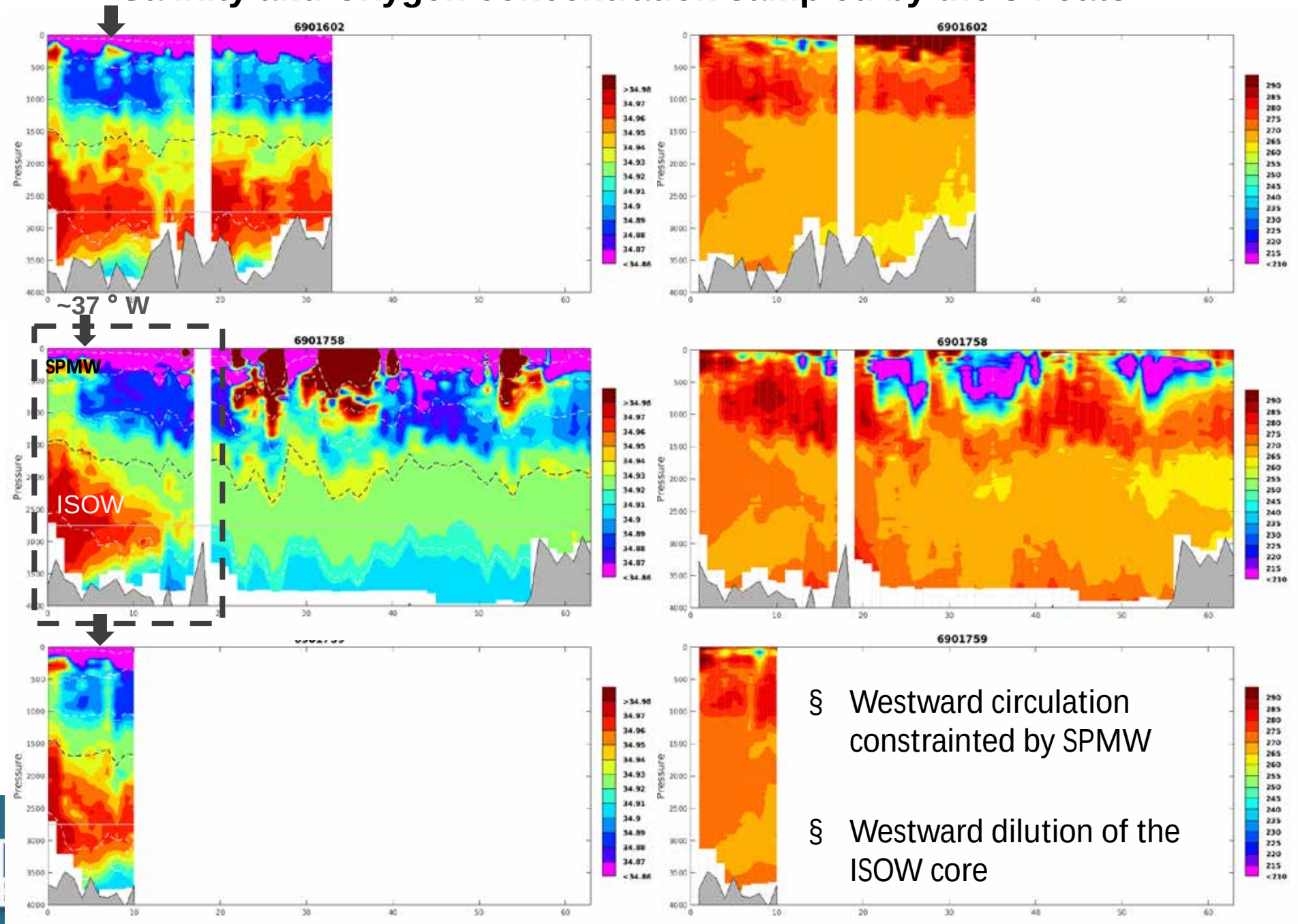


Absolute geostrophic velocity referenced to s-adcp data (m/s)
(com. pers. T. Petit)



Eastward Baroclinic structure from surface to depth

Salinity and Oxygen concentration sampled by the 3 floats



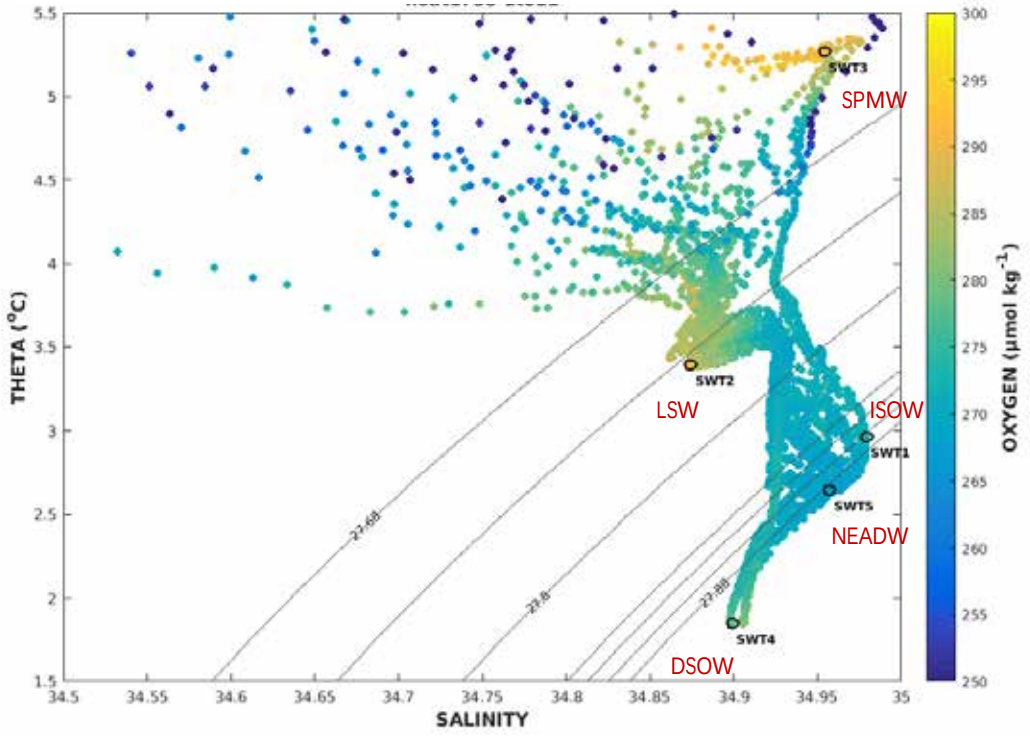
- Westward circulation constrainted by SPMW
- Westward dilution of the ISOW core

Scientific analyses

Optimum Multiparameter analysis to determine mixing coeficients for the deep layers ($27.8 < \sigma_0 < 27.88$)

WORK IN PROGRESS

Θ-S-O_2 diagram for cy. 1 to 21 of red float

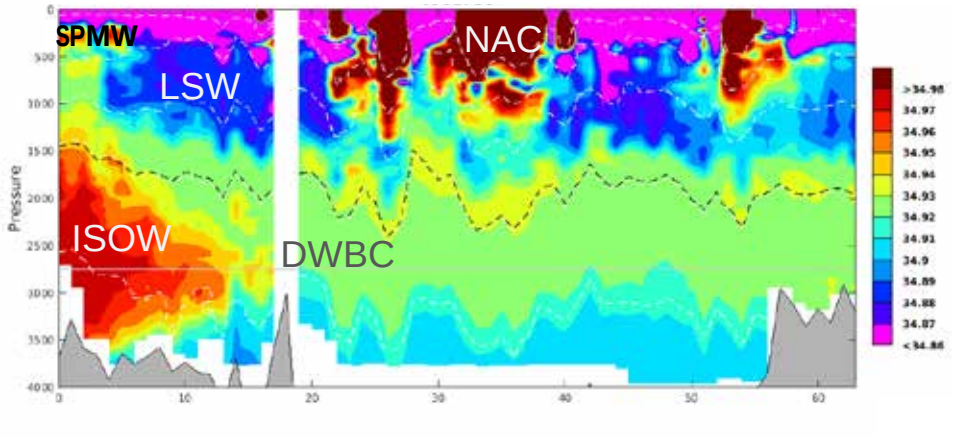


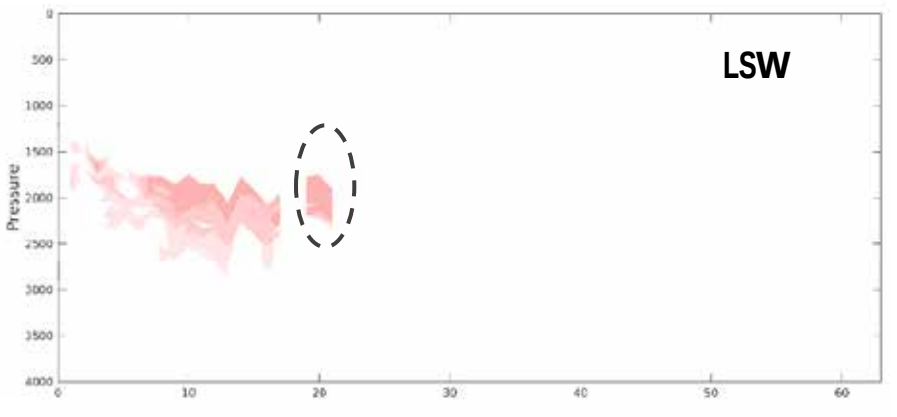
Methodology

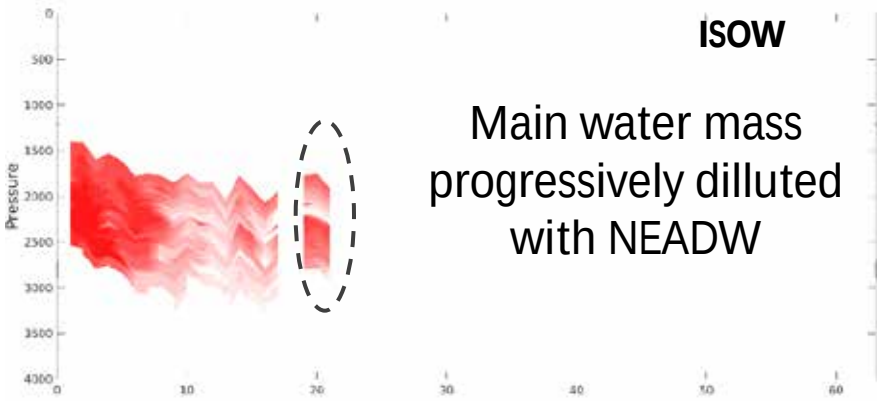
- § Define the source water types (SWT)
- § Define the weigth (W) of each parameters (j = Θ,S,O_2 + mass conservation)
- § Define mixing figures (no more than 3 SWTs for our case)
- è Vertical limit ($27.8 < \sigma_0 < 27.88$)
- è Various configurations; for example (1) SWT1 – 2 and 3; (2) = SWT1 – 2 4 …
- è Identify the best configuration

Final residual = sqrt[$\Sigma(res_j^2 / W_j^2)$]

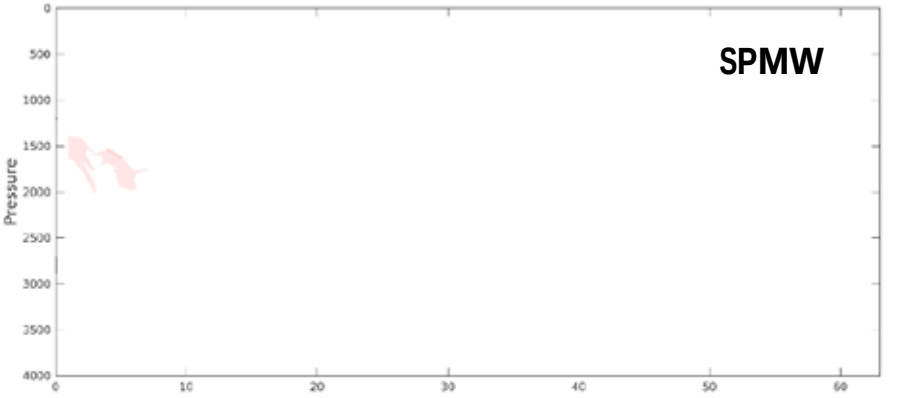
Water masses contribution between σ_0 27.8 and 27.88 – OMP results

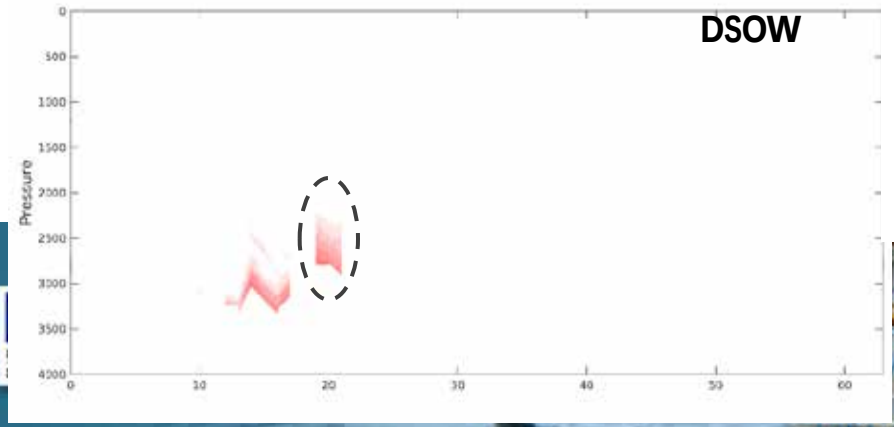


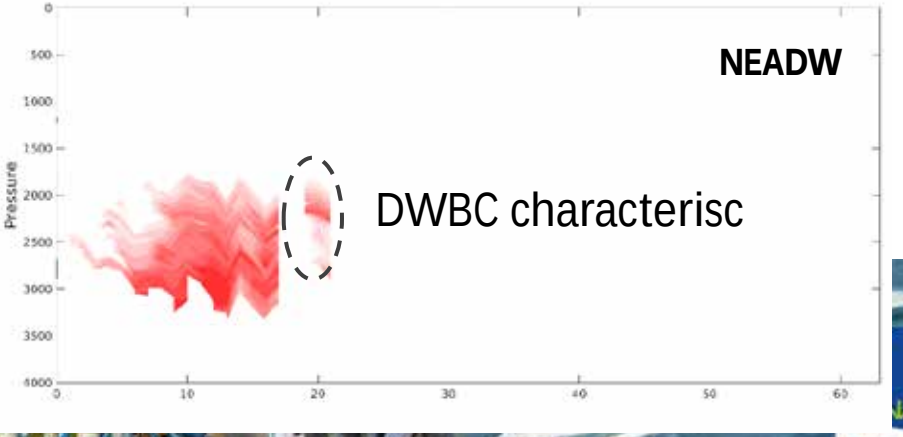




Main water mass progressively dilluted with NEADW

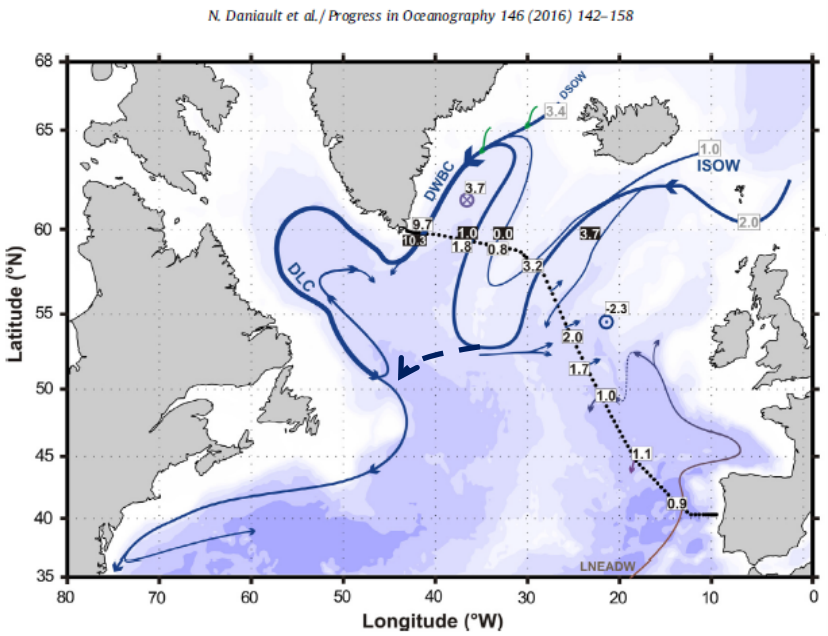






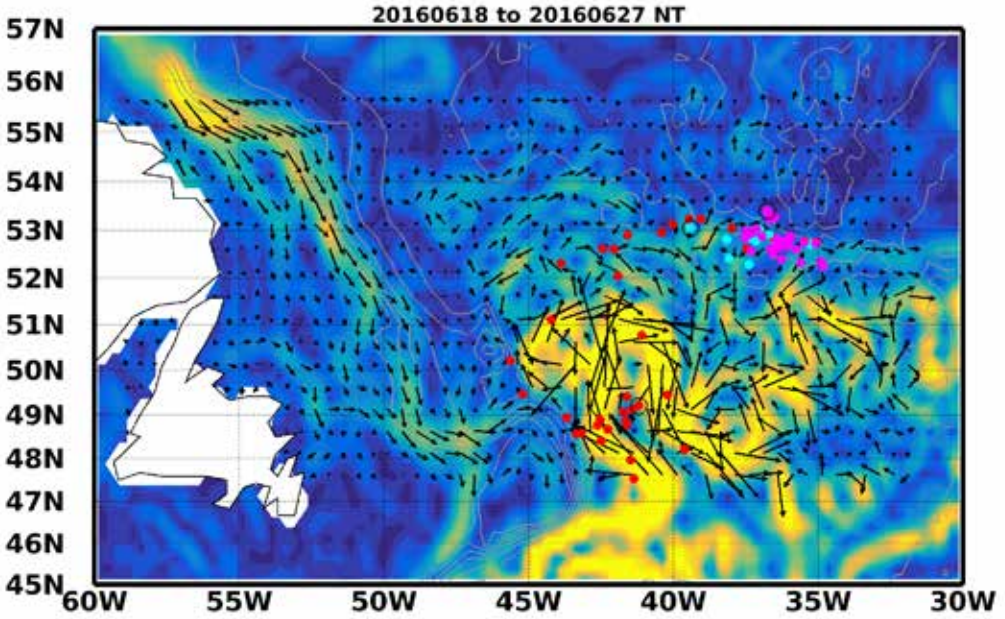
DWBC characterisc

Summary and Future work



Surface geostrophic velocity (m/s)

(AVISO+, resolution averaged on one Deep-Argo cycle)



§ Deep circulation : Direct trajectory from CGFZ to the DWBC (suggested by McCartney (1992)

- è Why is it not here ? Is it permanent ? What is the role of SPMW?
- è Is it a response to the change in atmospheric forcing (NAO^{neutre} >> NAO^{+})?

§ Westward erosion of ISOW core

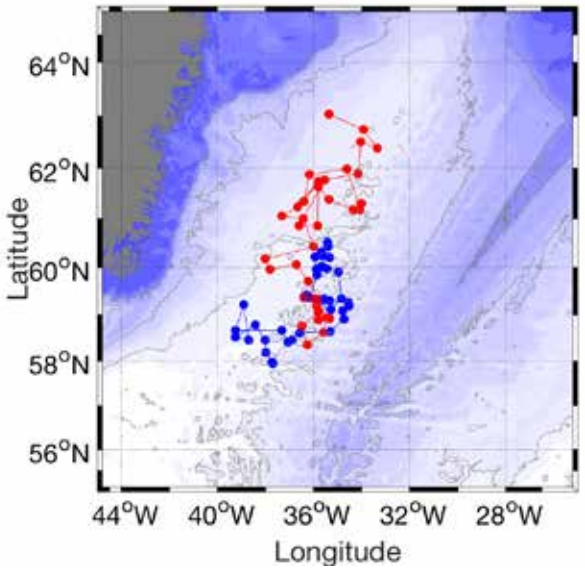
- è evaluation of the mixing coefficient (work in progress)

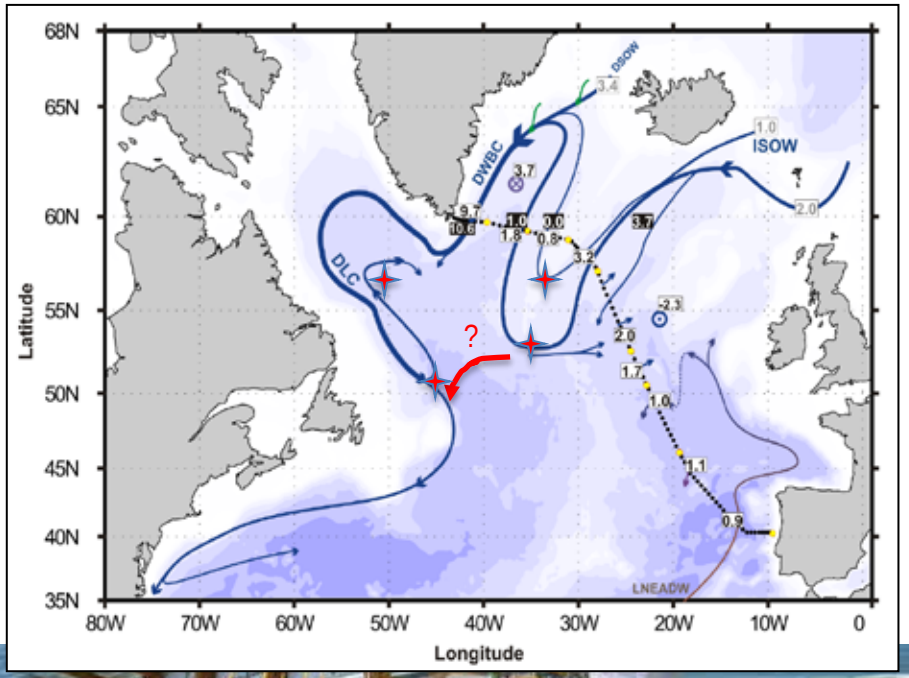
§ Influence of the NAC on the Deep circulation.

- è How? What are the consequences on the propagation of climatic anomalies

Perspectives

- **Continue deployment of Deep-Arvor data in the North-Atlantic ocean**
  - 11 remaining NAOS floats
  - CPER Euro-Argo floats (15 floats/year available, some via the GMMC)
- **Scientific objective: Formation, pathways and mixing of deep water masses**





Perspectives

- **Maintain the North-Atlantic Argo-Deep pilot array**
  - Technological issue: Float and sensor evaluations
  - Strategy assessment : density, parking depth, cycling period, cost
  - Demonstration of data value on a short term
  - Initiate Deep-Argo time series to address the Deep-Argo objectives in 10 or 20 years from now.

North-Atlantic Deep pilot array

Program	Funding	Scientific project	Float type and numbers	Deployment	Region
Argo-France	NAOS V. Thierry	OVIDE, RREX, OSNAP	16 Deep-Arvor	2017 and 2018	Subpolar gyre (3 in Southern Ocean)
Euro-Argo	AtlantOS	OVIDE, RREX, OSNAP, others	7 Deep-Arvor	2017 and 2018	North-Atlantic
Argo-France	CPER Euro-Argo (Brittany)	OVIDE, RREX, OSNAP	15 Deep-Arvor/year (5 years)	2018-2022	North-Atlantic
Argo-UK		OSNAP, RAPID, ?	8 Deep-APEX O2	2017	?
Argo-US	Deep-Argo SIO		6 Deep-SOLOS	2017	Rapid Line at 26 ° N