

A Deep Coherent Eddy in the northern Norwegian Sea observed with Argo floats.

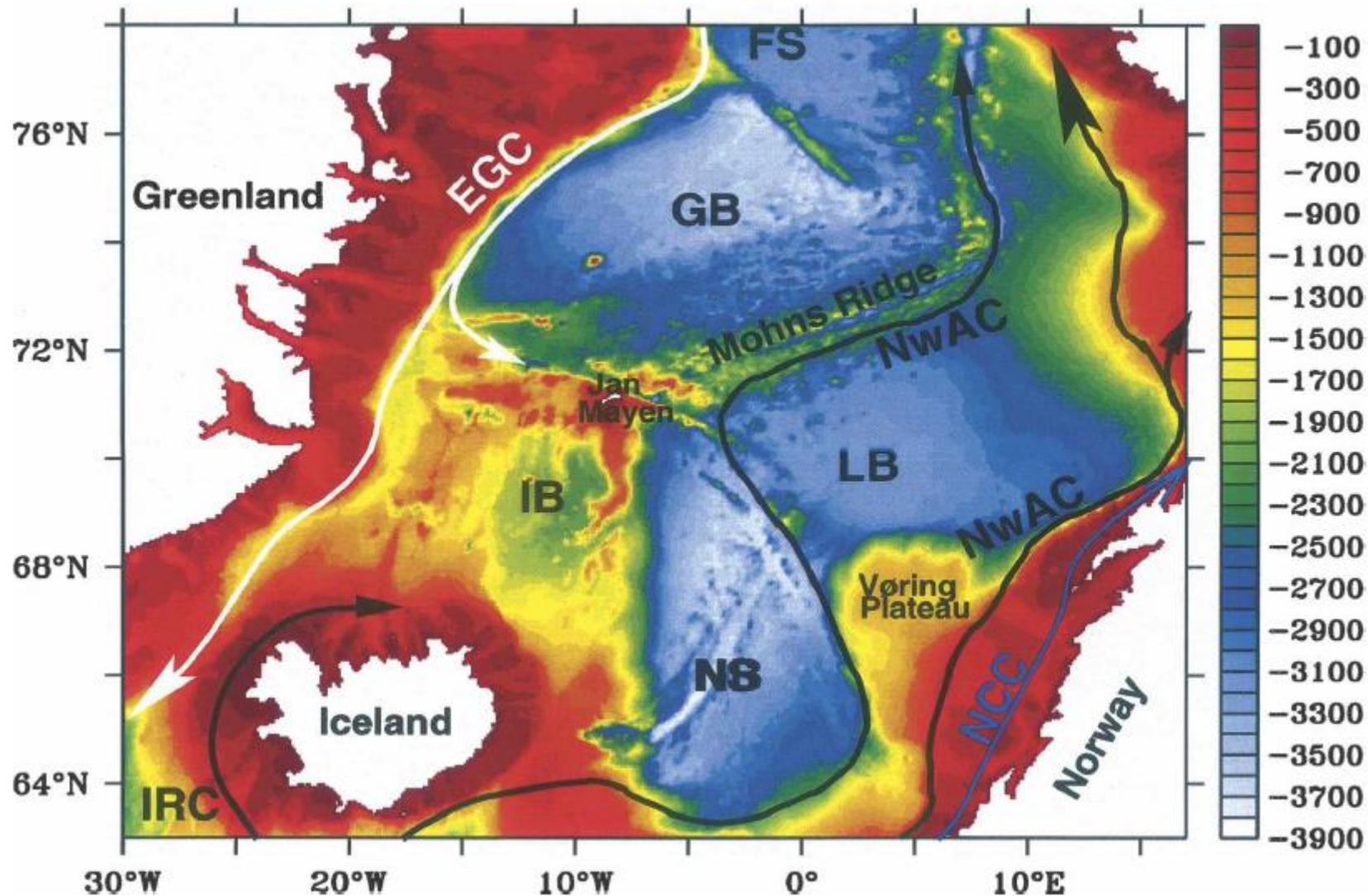


Henrik Søliland and Kjell Arne Mork
Institute of Marine Research

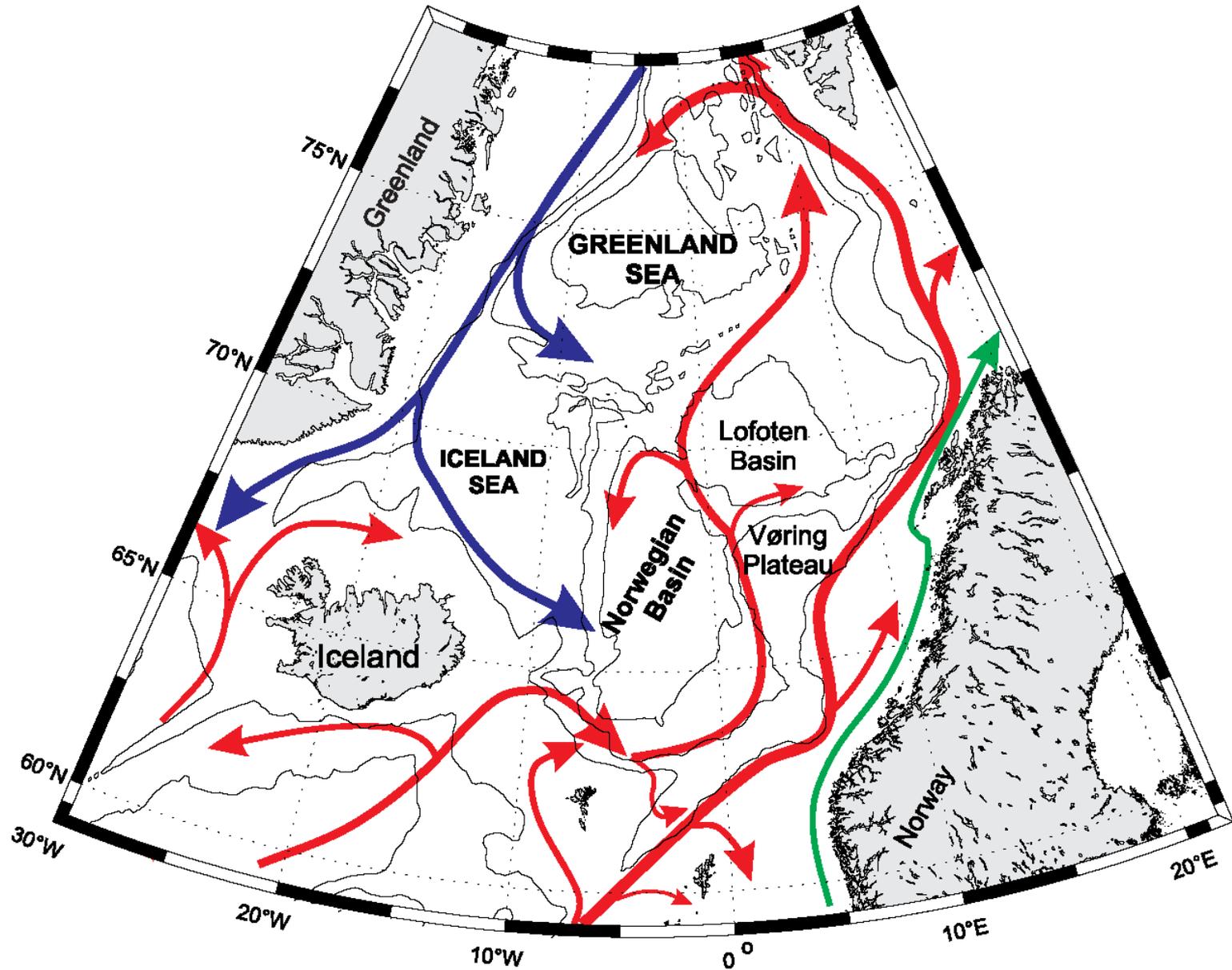
Outline

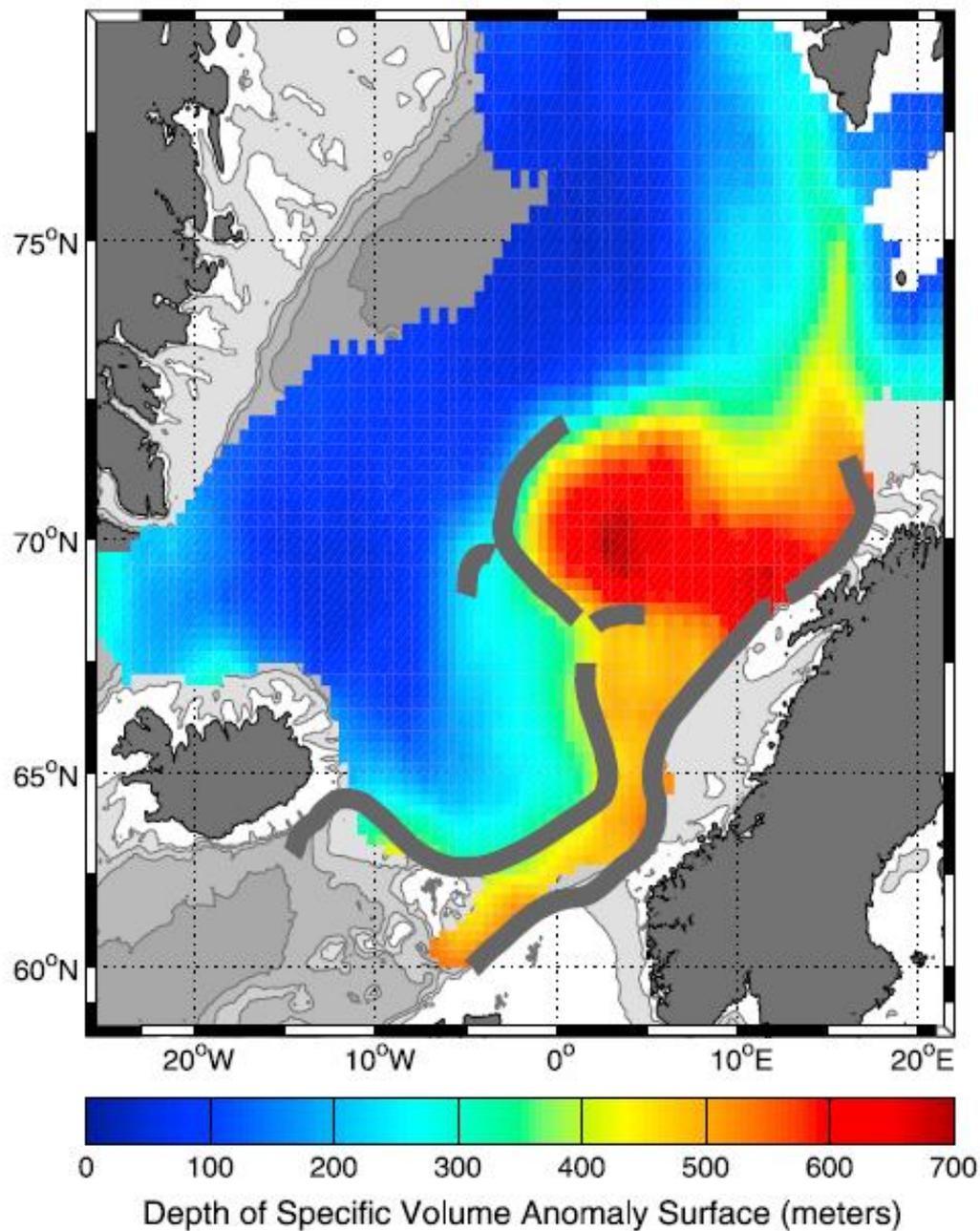
- Nordic Seas - a short overview
- Properties of the Lofoten Basin Eddy (LBE)
- Argo floats deployed in the LBE in May 2019

Bottom topography



Surface circulation





Depth of $\sigma_t \sim 27.9$ surface
($2.1 \times 10^{-7} \text{m}^3 \text{kg}^{-1}$)

Spall, 2010: Steep slope \rightarrow
instability in slope current.
Presence of mid basin ridge

18 May 2011

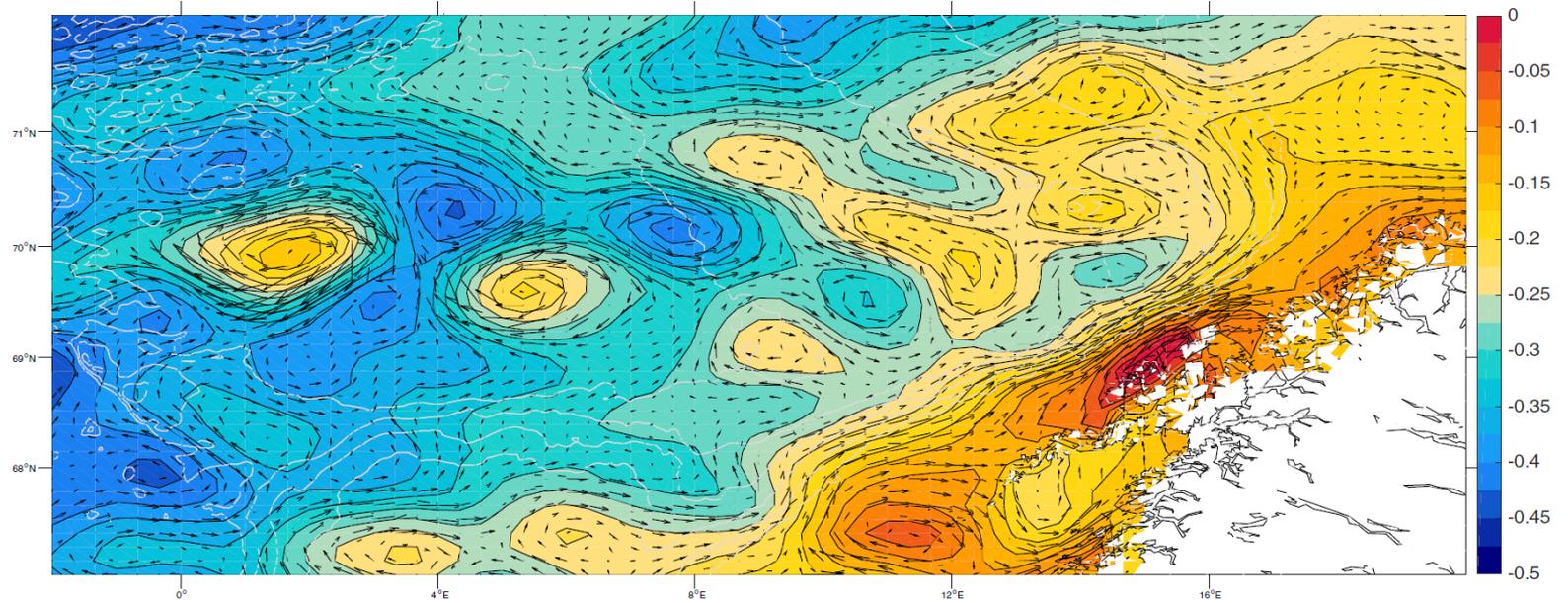


Figure 6. SSH for the Lofoten Basin at the time of the LBE survey in 2011. Note the LBE farther west than usual and the LE close to the normal position of the LBE. The gray contours indicate the bathymetry with a spacing of 500 m.

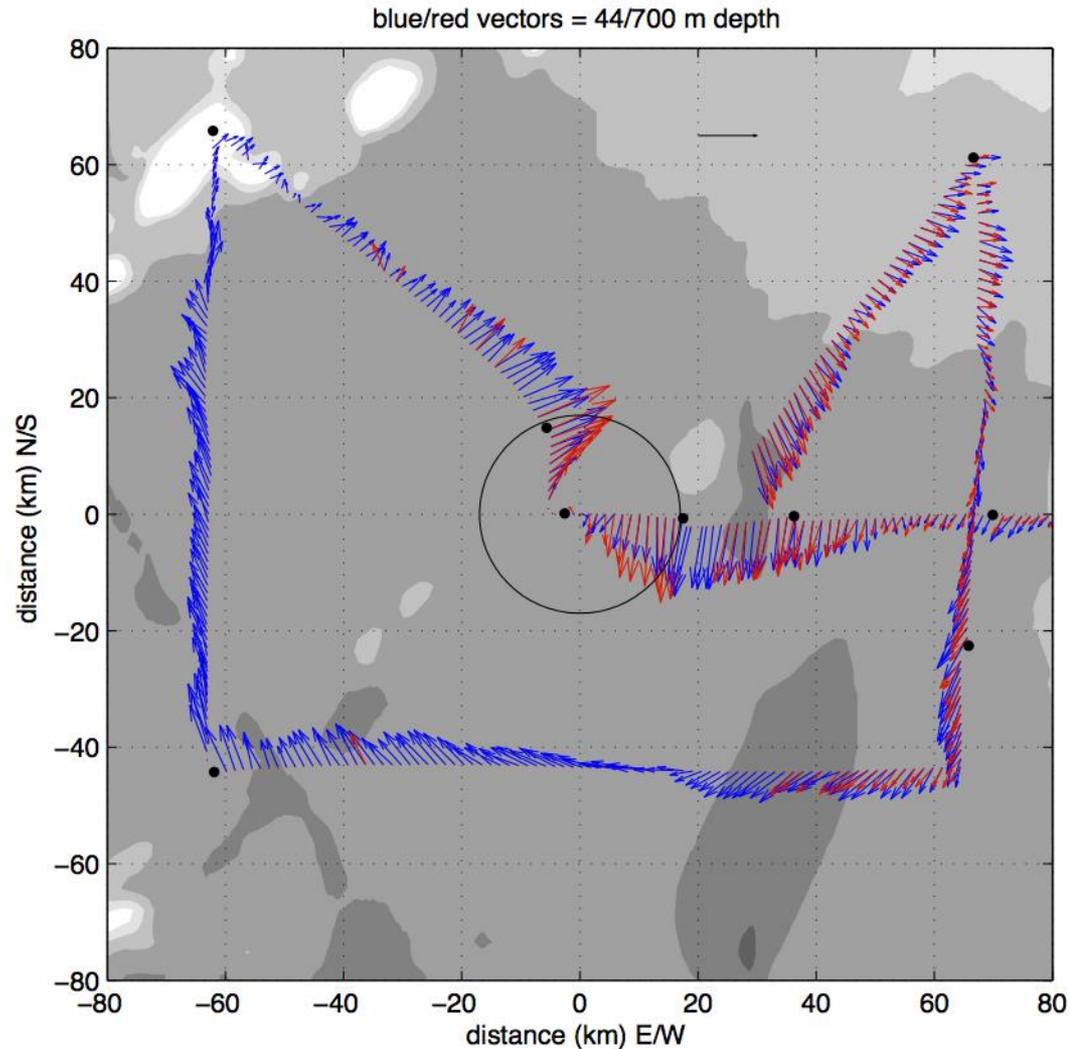
Lofoten Basin

Eddy survey - July 2010

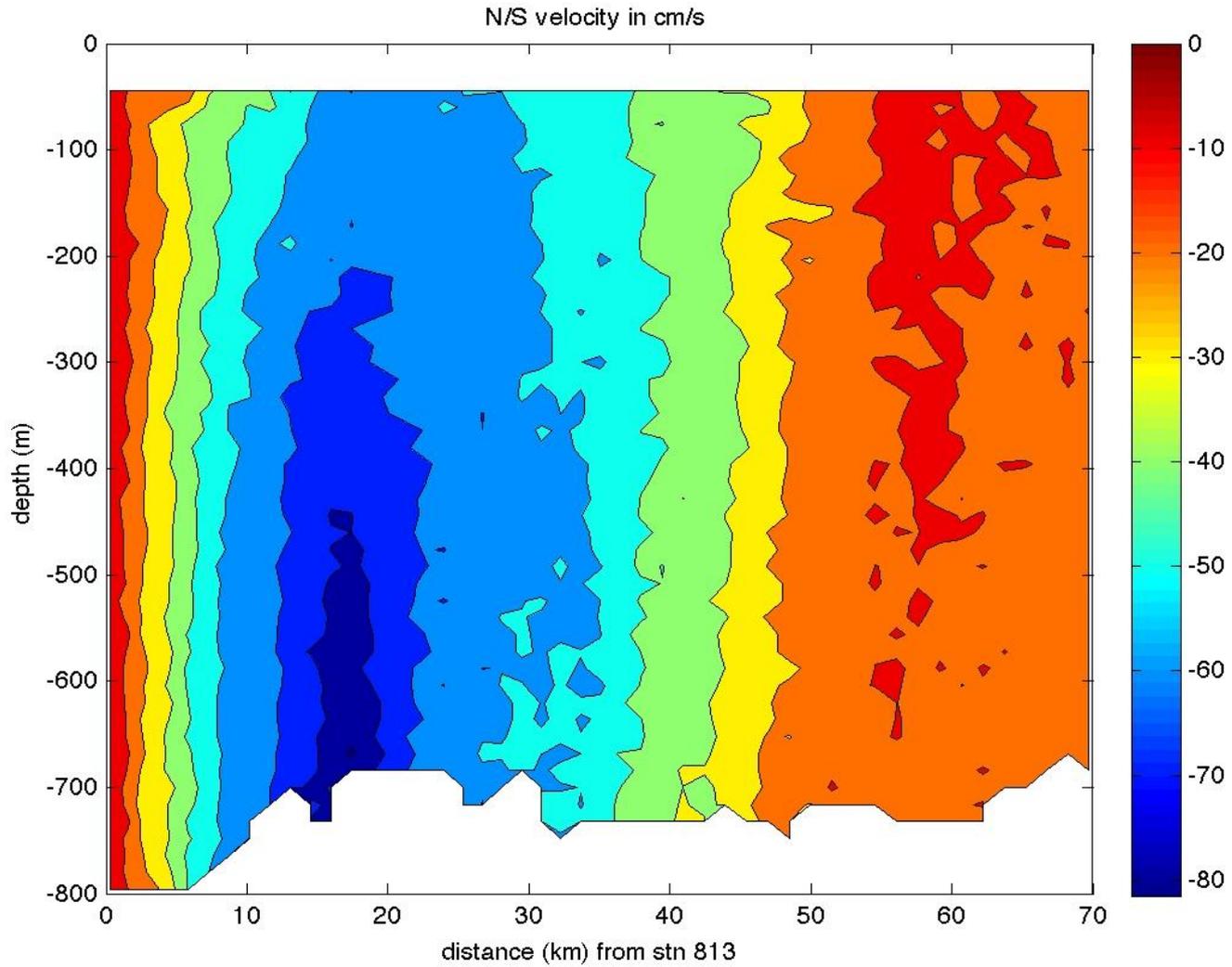
- CTD
- VM - ADCP
- Deployed RAFOS floats

ADCP - Survey July 2010

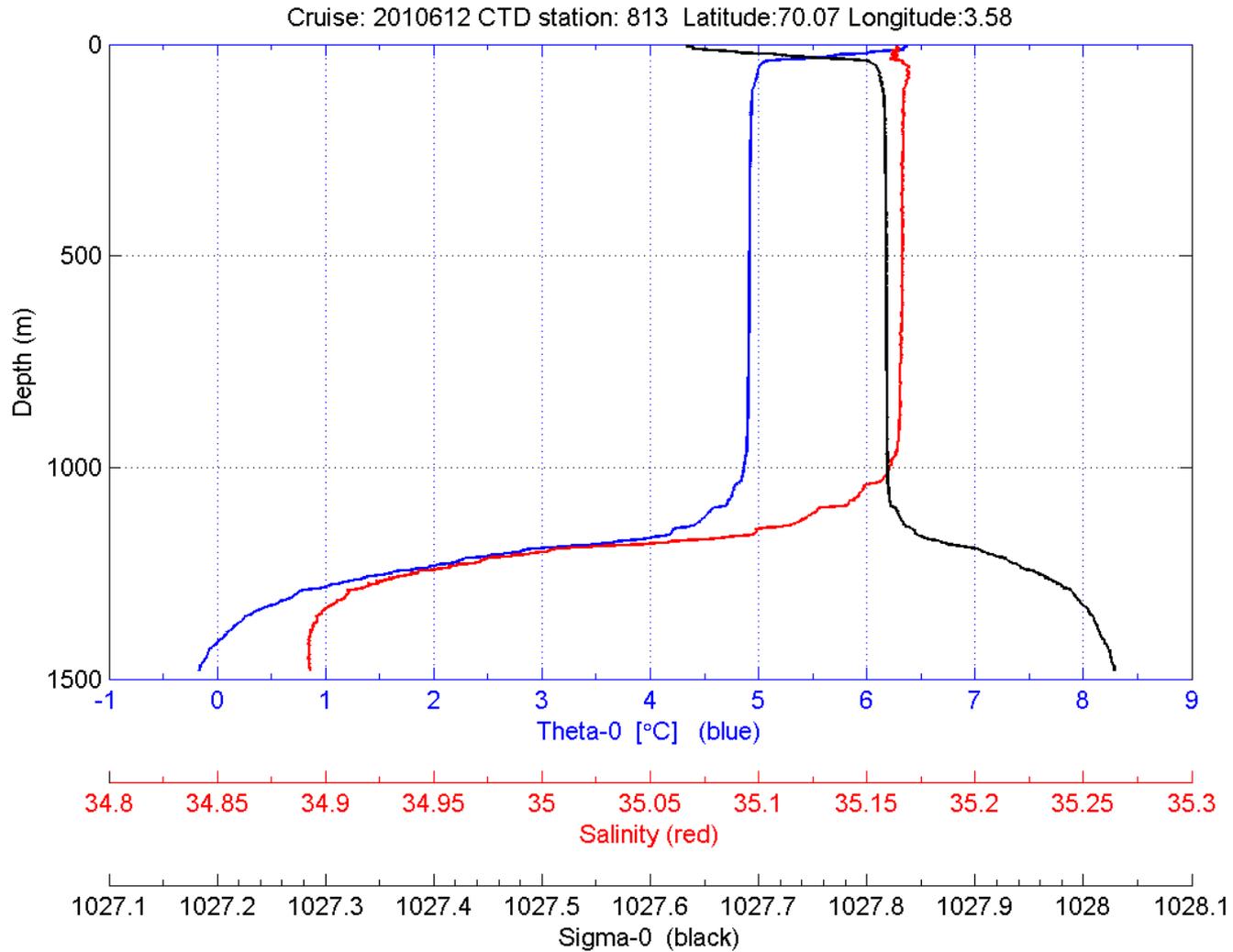
Velocity at 44 m (blue) and 700 m (red)



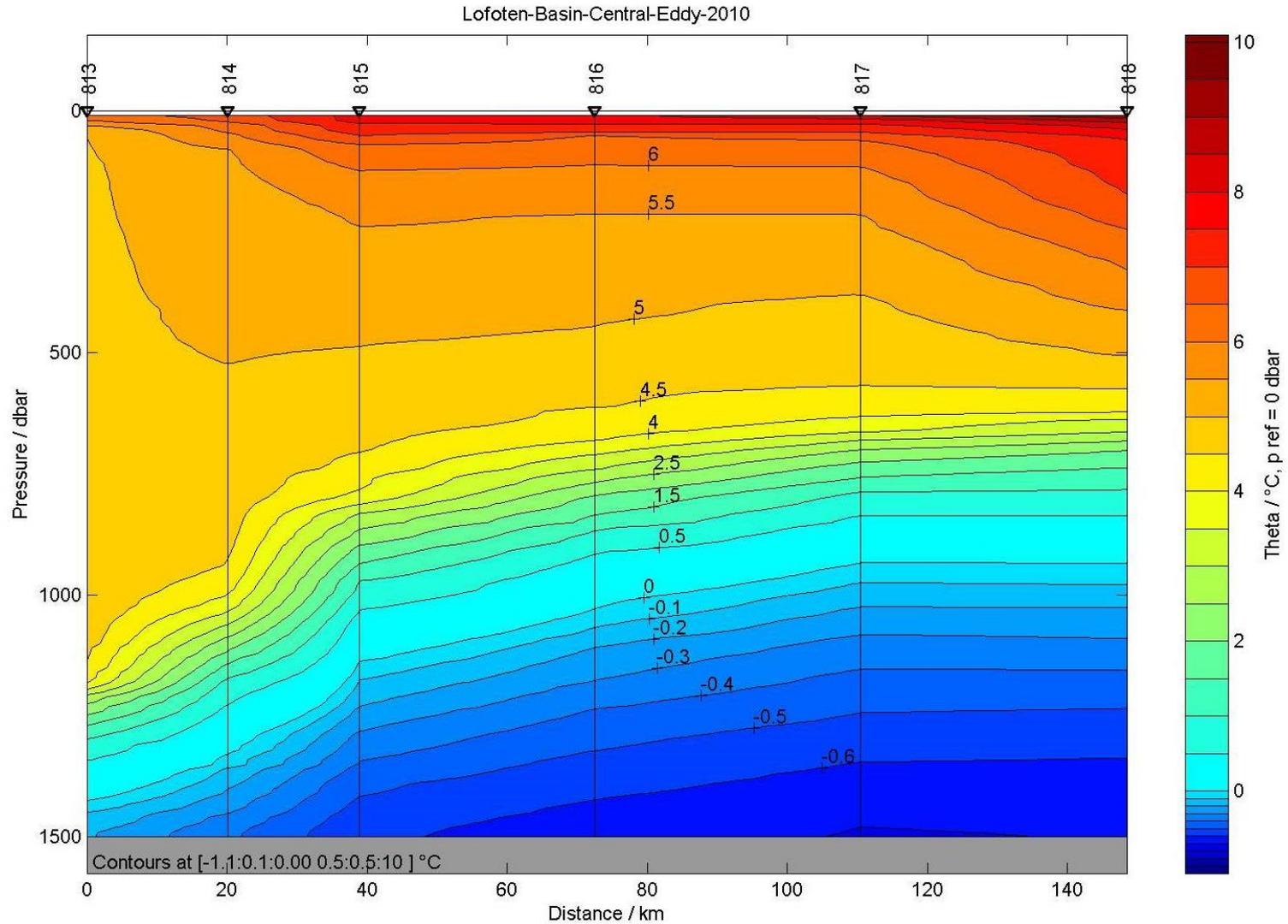
Azimuthal velocity section



CTD – Center of LBE - 2010



T – section (Center → eastward)



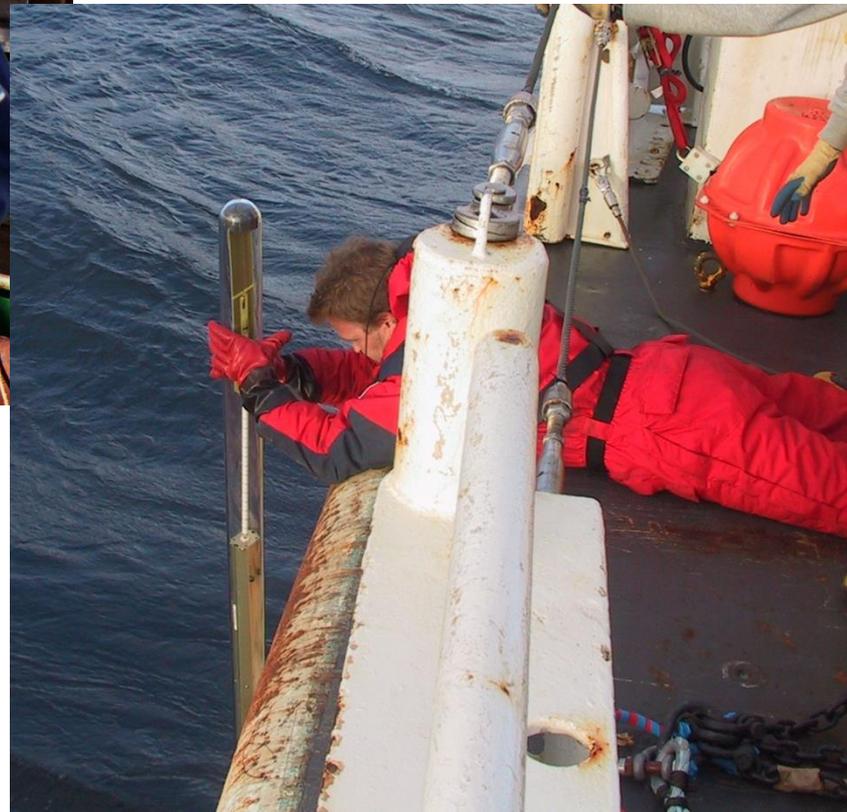
LBE

- Solid body eddy core to 8 km radius
- Core – "homogenous" down to 1000-1200 m
- Max swirl velocities 80-100 cms^{-1} , at 18-20 km radius
- Rotation period close to one pendulum day = 25.5 hrs
- Relative vorticity near $-f$
- Evidence that the LBE is permanent, at least 50-60
- Maintained by merging anticyclones
- Anticyclones formed by instabilities in the NwAC at the Lofoten Escarpment and propagate westward
- Deep winter convection modifies water properties

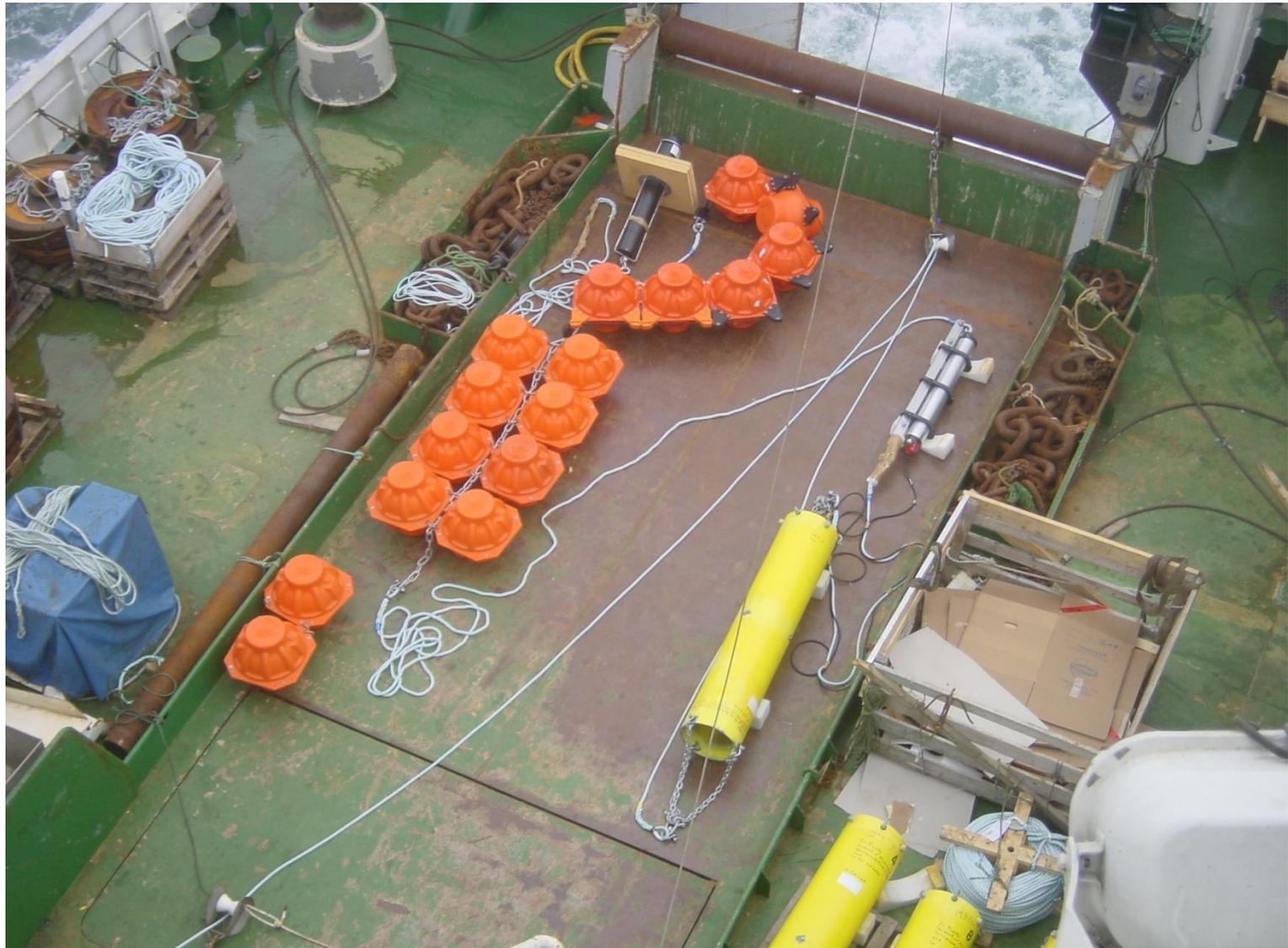
RAFOS floats June 2016 –August 2017

- 18 RAFOS deployed in pairs at 250, 550 and 850 m in 3 positions
- Deployed in the center
 - All at 850 m remain in eddy – 15 months
 - All at 560 m remain in eddy – 15 months
 - All at 250 m out after 250-300 days

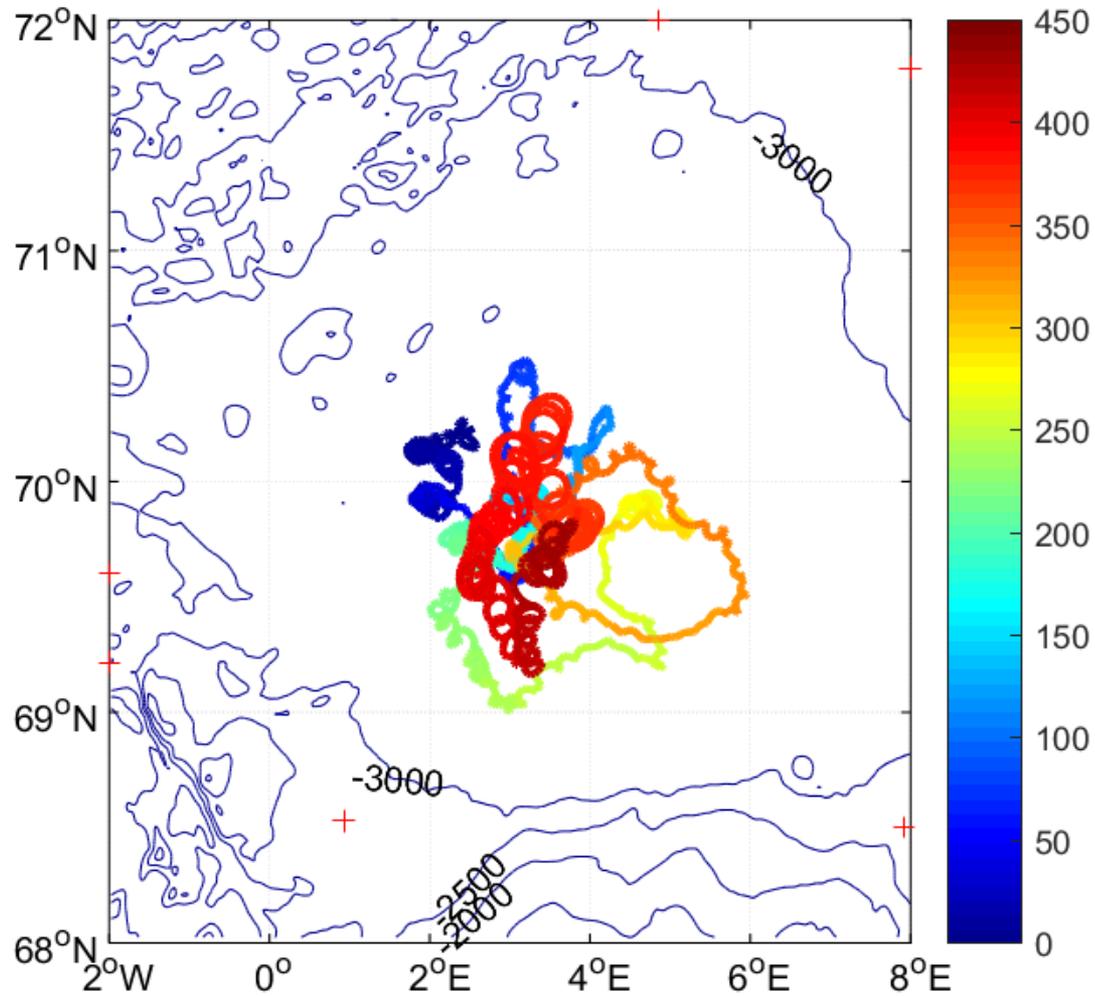
RAFOS-float



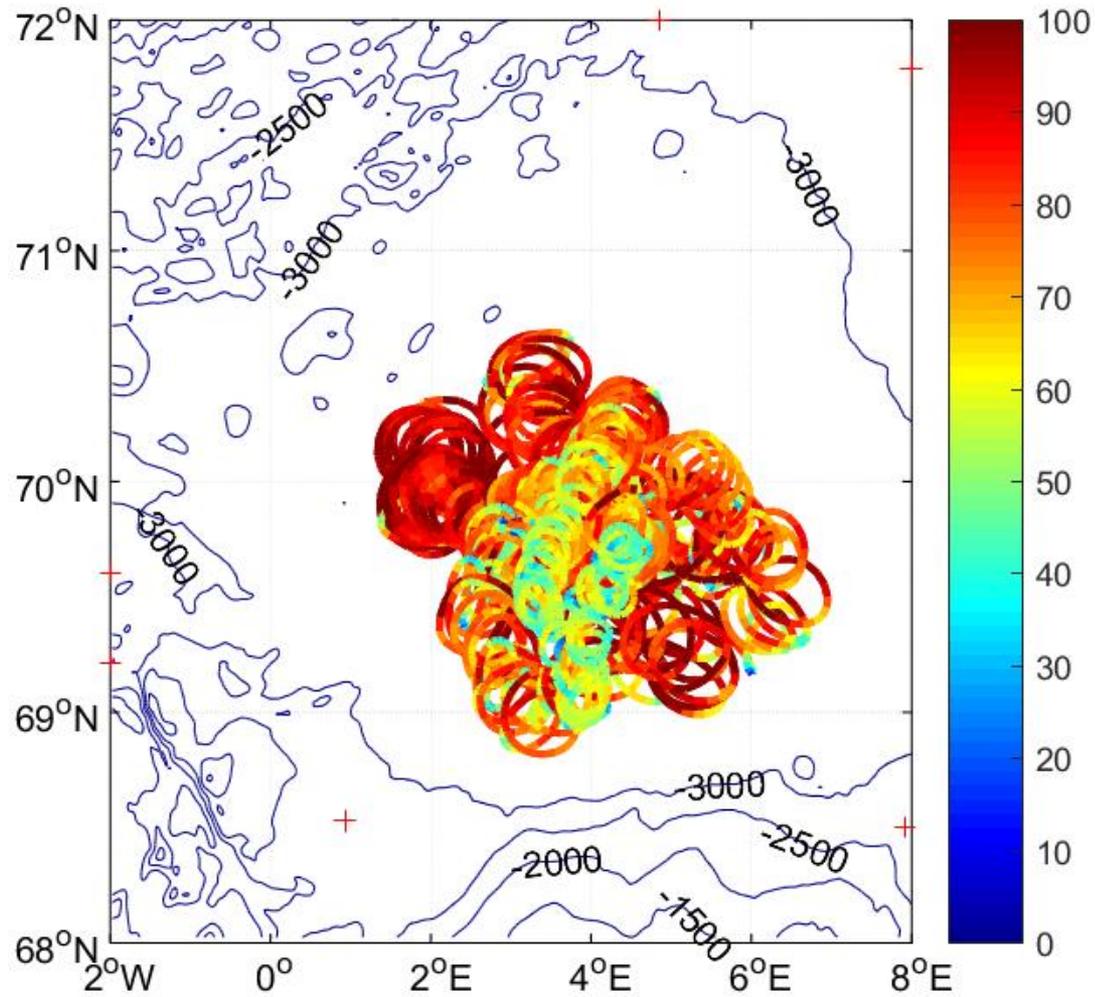
Sound source



RF1448 – Elapsed time



RF1203 -Speed



Conclusions

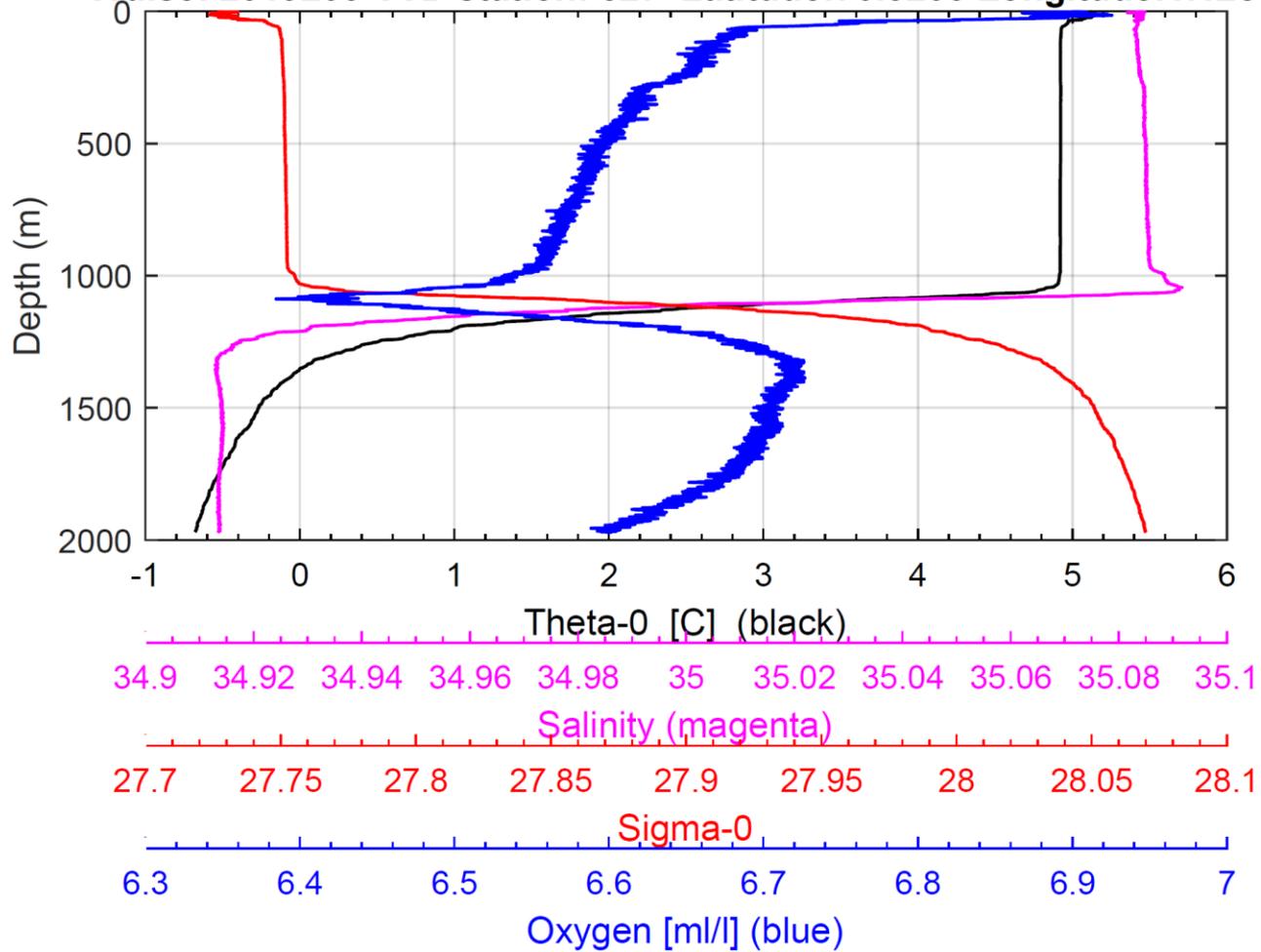
- Little exchange between deep core (500-900 m) and surroundings
- Long residence times (200-300 days) for floats in the core above 400- 500 m. Expelled during events – eddy interaction and/or convection.
- Outside the core the exchange is increasing with radius.

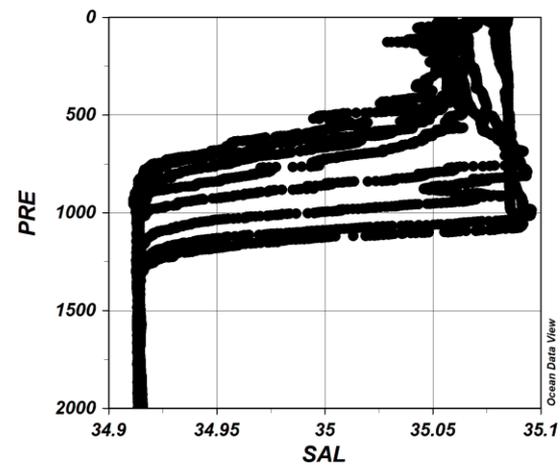
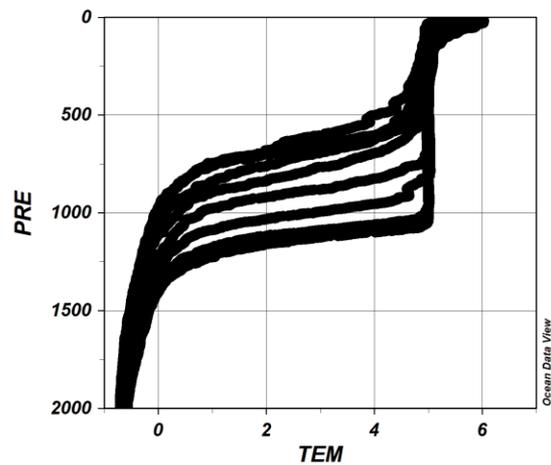
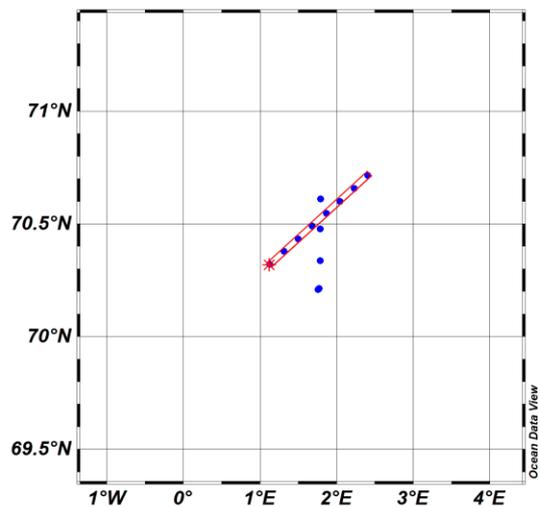
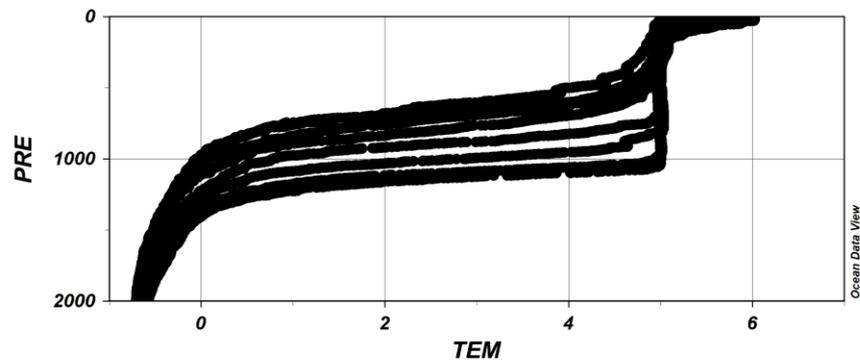
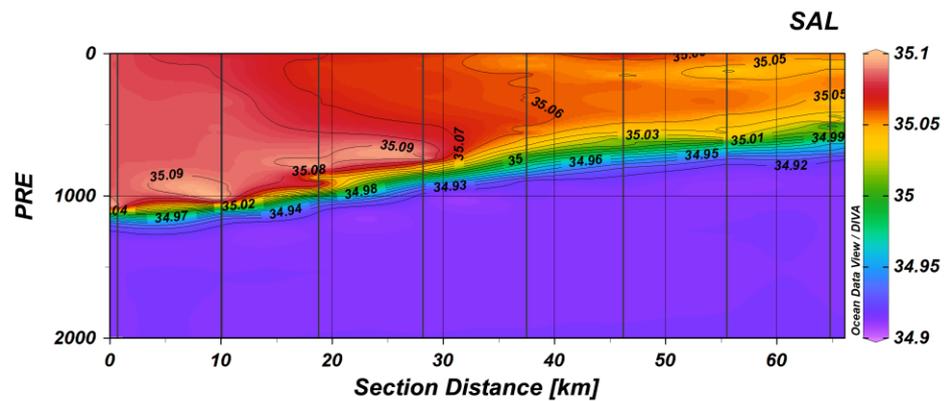
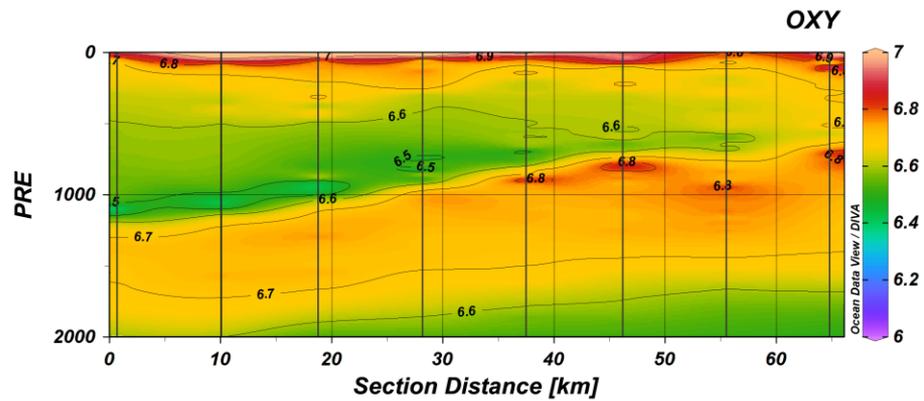
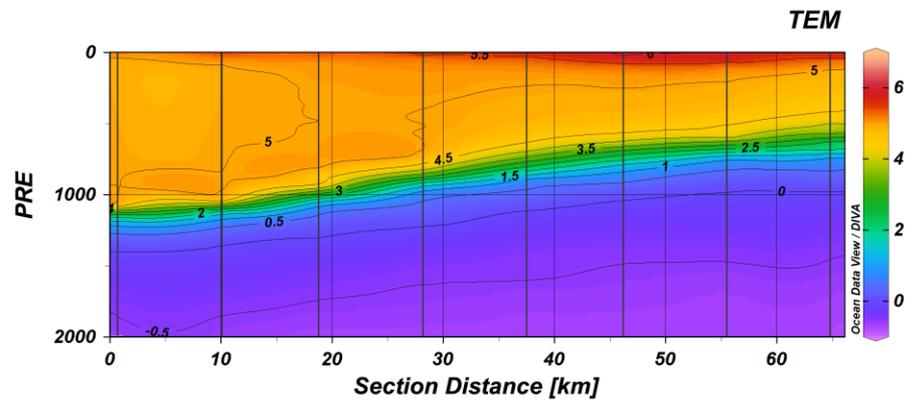
Argo deployments in the core of the LBE

May 2019

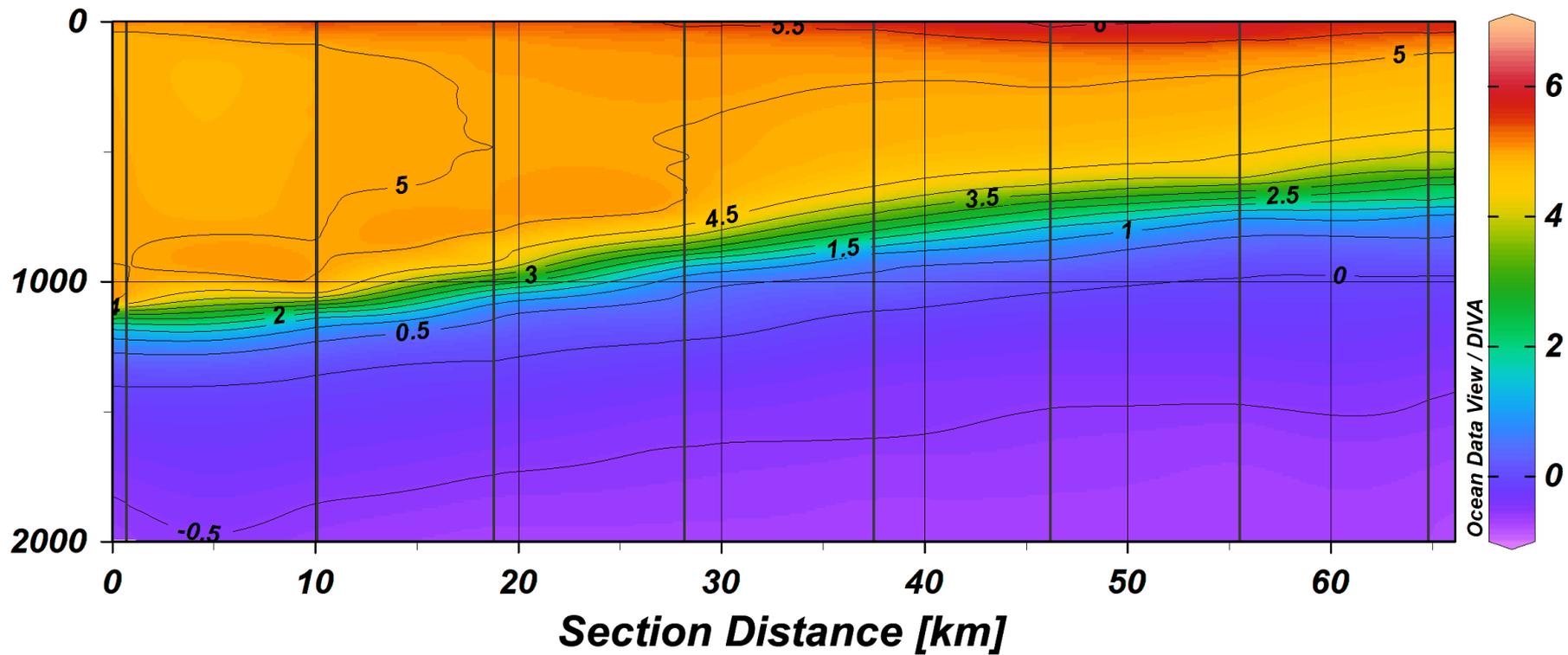
- **1 BGC**
 - Park depth 1000m
 - Profile depth 2000m
 - 5 day interval
- **1 Bio**
 - Park depth 800m
 - Profile depth 2000m
 - 5 day interval
- **1 Deep**
 - Park depth 1000m
 - Profile depth bottom (~3300m)
 - 10 day interval

Cruise: 2019205 CTD station: 527 Latitude:70.3205 Longitude:1.1283



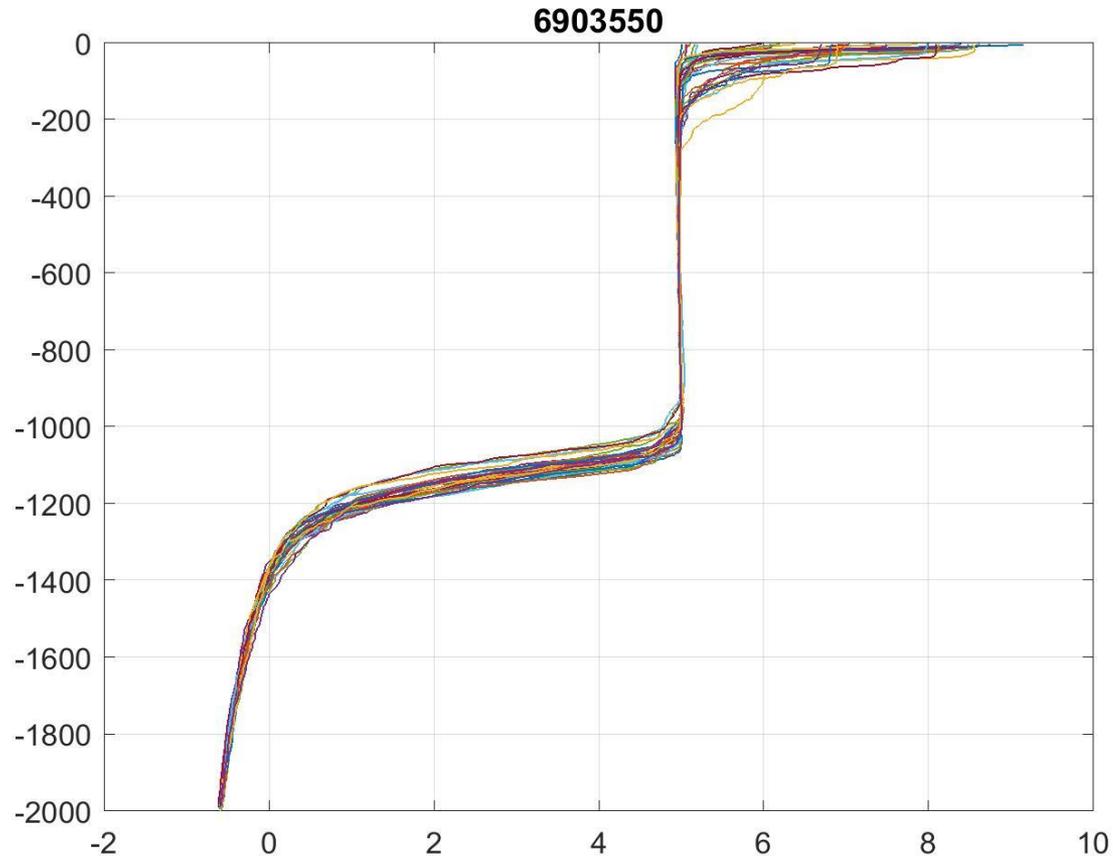


TEM

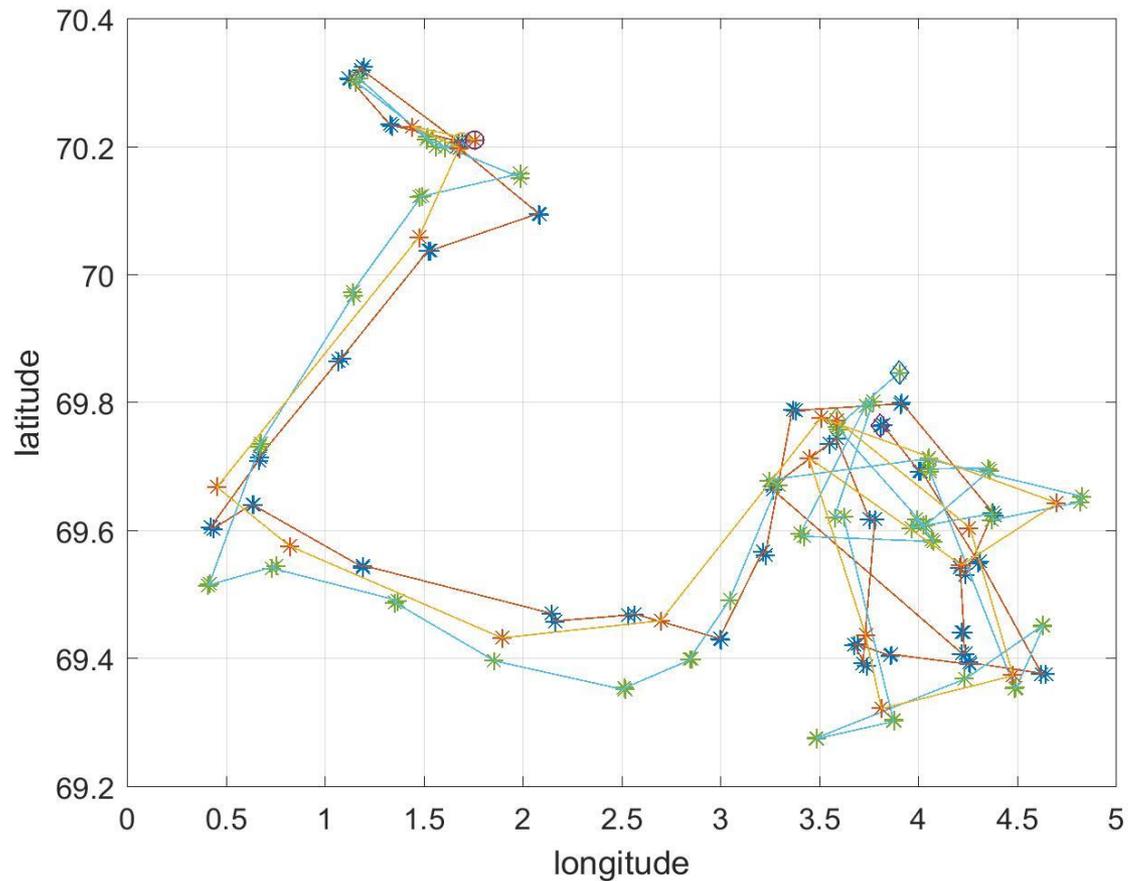


Temperature ; May-October

All profiles

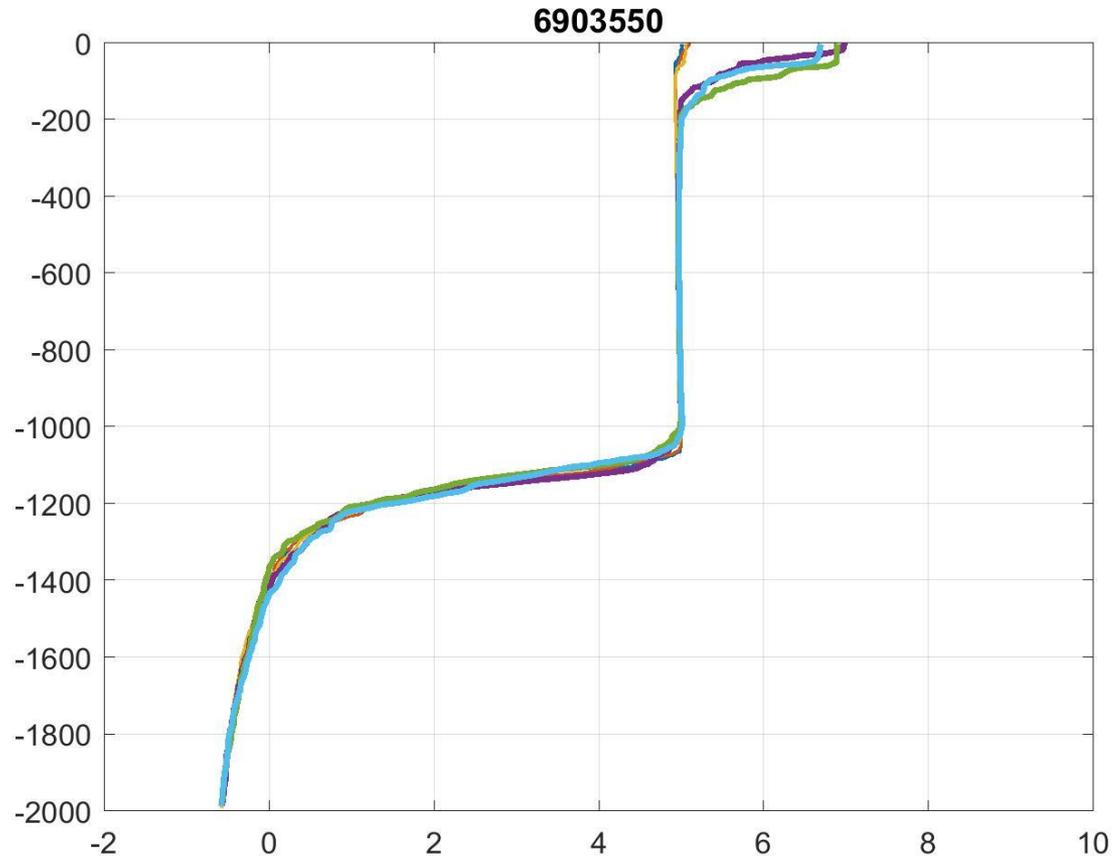


Surface positions 3 Argo floats in the LBE; May-October 2019



Temperature ; May-October

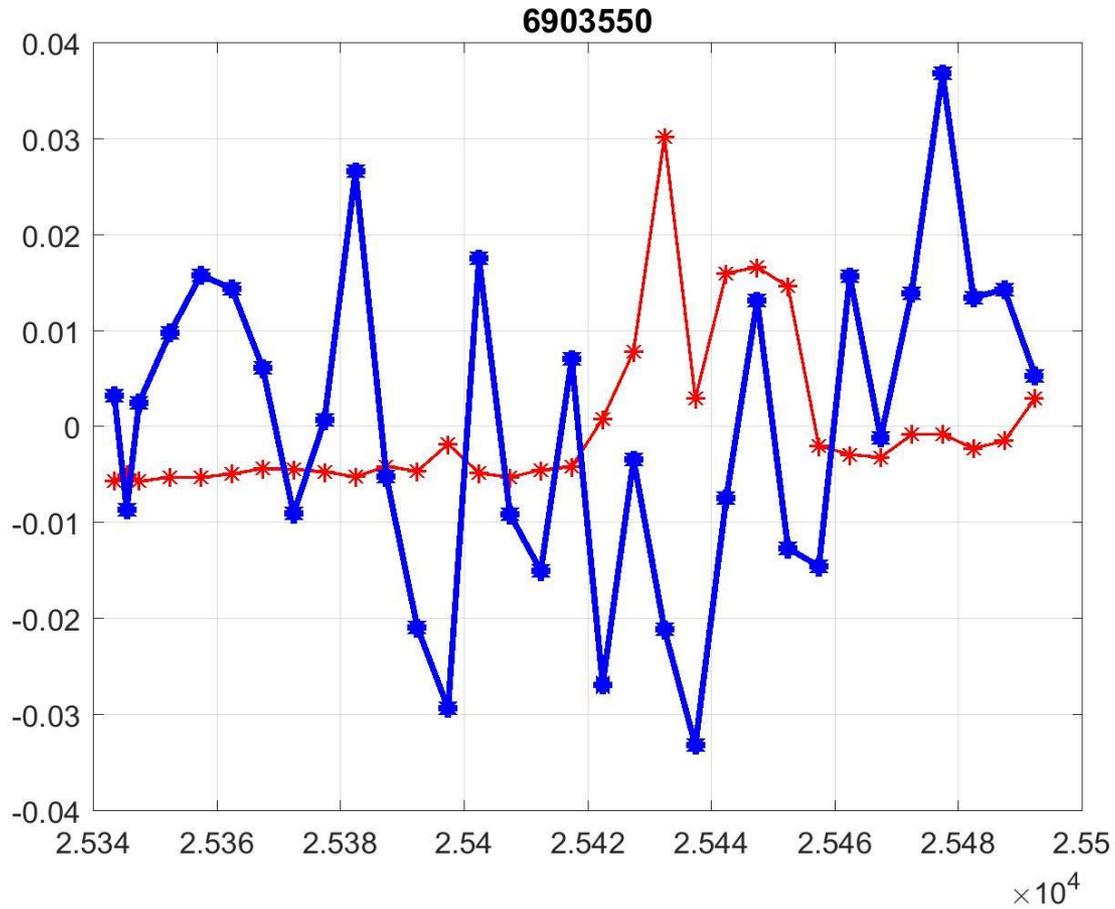
3 first – 3 last



Temperature anomaly ; May-October

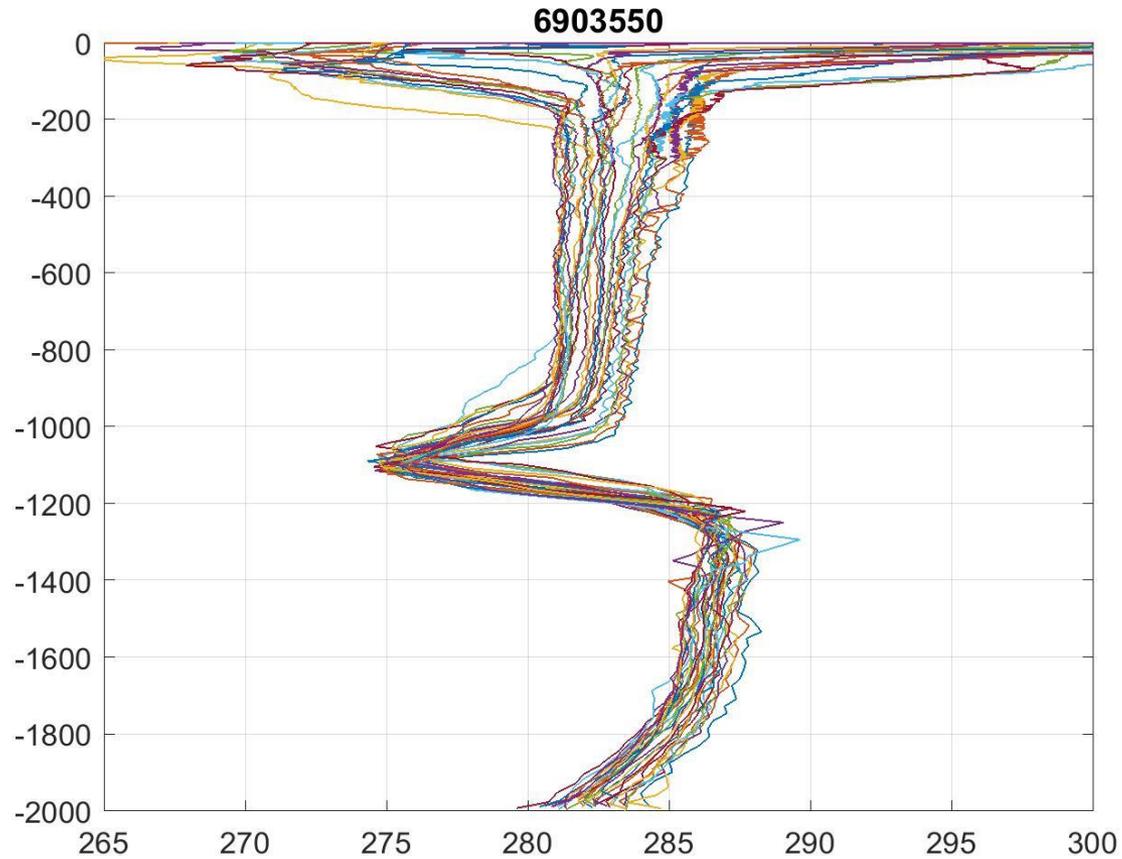
Red: 600-800m

Blue: 1800-2000m



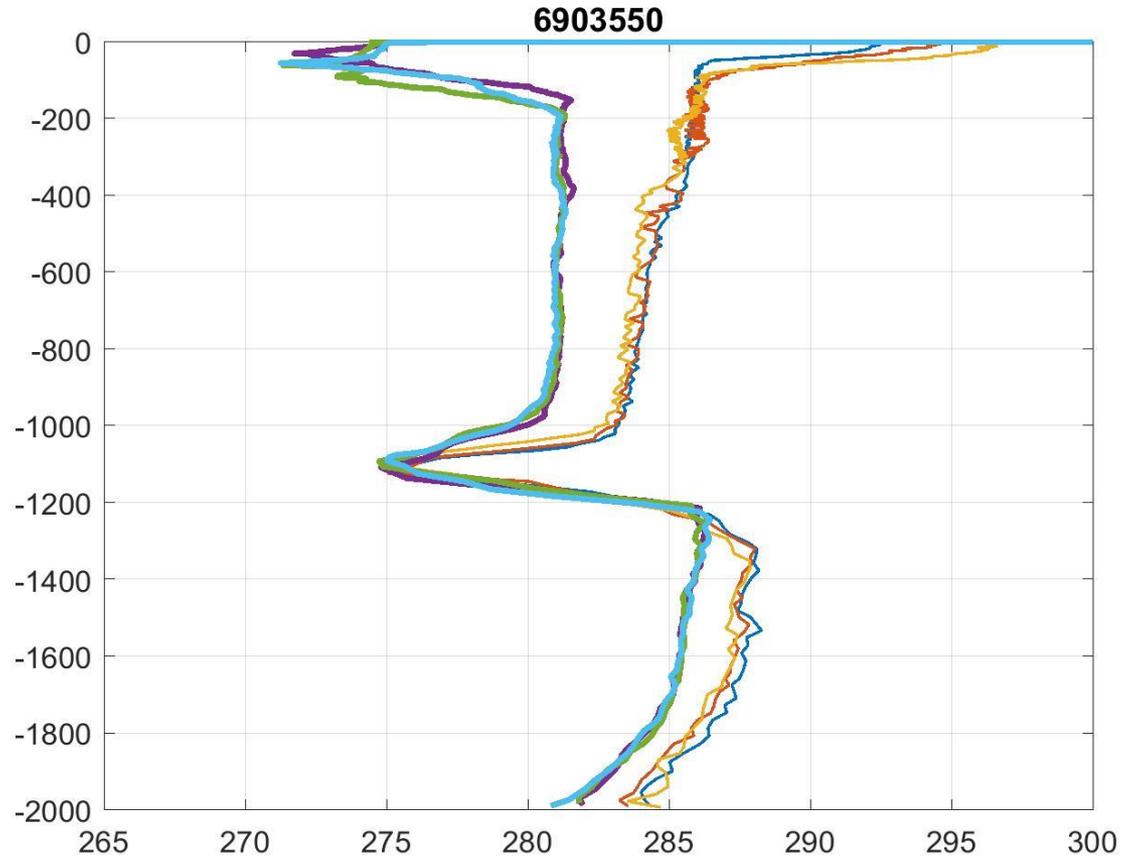
Oxygen ; May-October

All profiles



Oxygen ; May-October

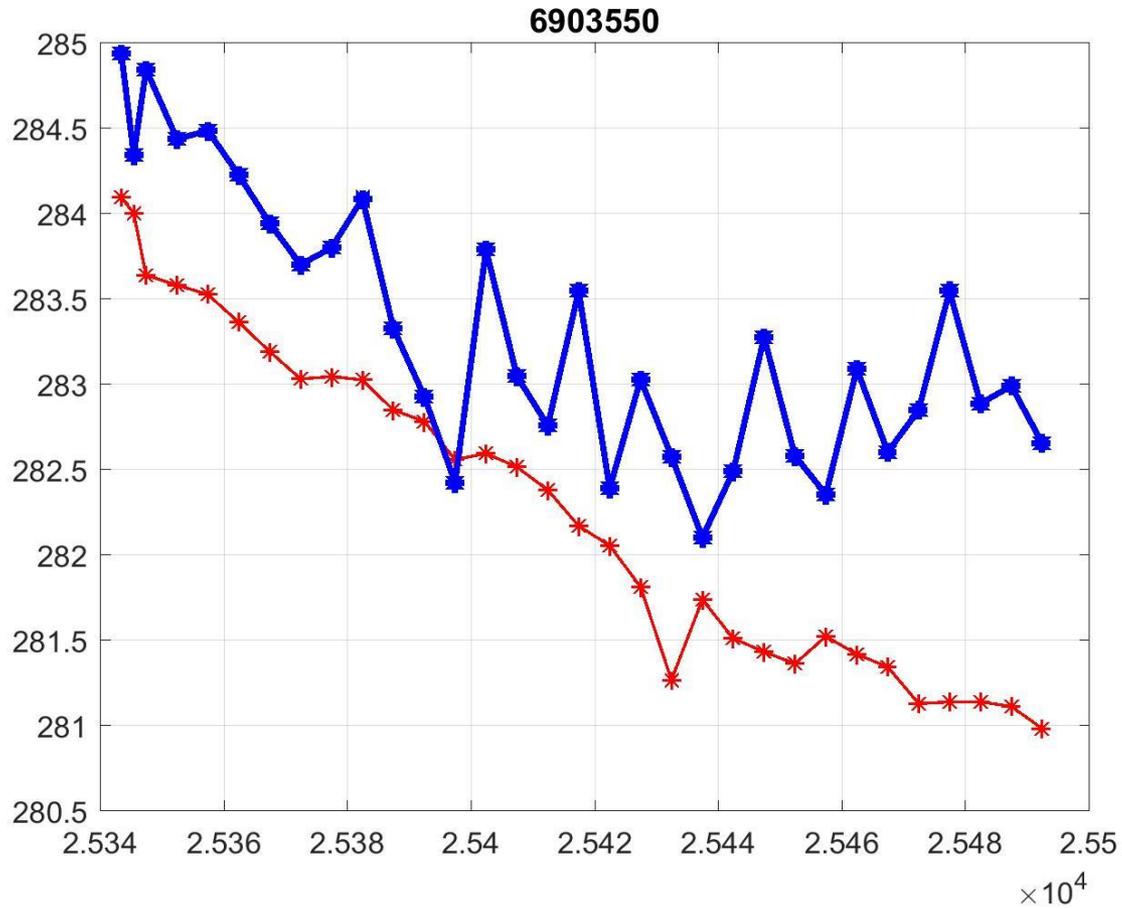
3 first – 3 last



Oxygen ; May-October

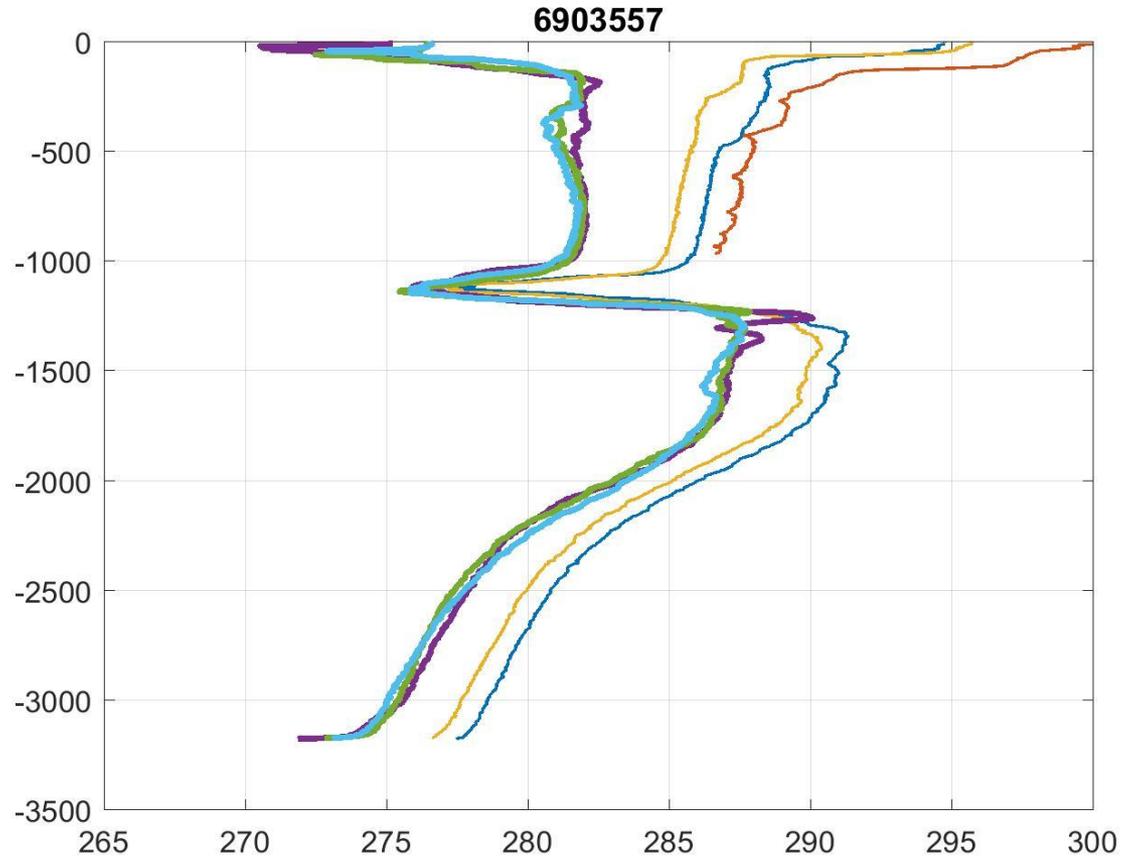
Red: 600-800m

Blue: 1800-2000m



Oxygen ; May-October

3 first – 3 last



Final remarks

- 3 Argo floats have remained in the core of the LBE from May – October 2019
- Except for the development of a seasonal mixed layer, small hydrographic changes

Summary – Lofoten Basin Eddy

- Anticyclonic eddy
- Max swirl velocity at depth ~800 m
- Max swirl velocity 100 cm/s at radius 18-20 km
- Solid body core – 8-10 km radius
- Relative vorticity in core close to $-f$
- Maintained by merging anticyclones
- Anticyclones formed by instabilities in the NwAC at the Lofoten Escarpment and propagate westward
- Deep winter convection modifies water properties
- Core – “homogenous” down to 1000-1200 m
- Evidence of a permanent eddy for 50-60 years
- Very plausible a permanent feature of the Norwegian Sea

- Sjøiland, H., L. Chafik, and T. Rossby, 2016. On the long-term stability of the Lofoten Basin Eddy, *Journal of Geophysical Research Oceans*, Vol 121, Doi: 10.1002/2016JC011726.
- Sjøiland, H. and Rossby, T., 2013. On the structure of the Lofoten Basin Eddy. *Journal of Geophysical Research*, Vol 118 , Doi: 10.1002/jgrc.20301