Évènement de convection profonde de l'hiver 2011-2012 dans la mer d'Irminger: observation à l'échelle du bassin grâce aux données Argo

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Summary

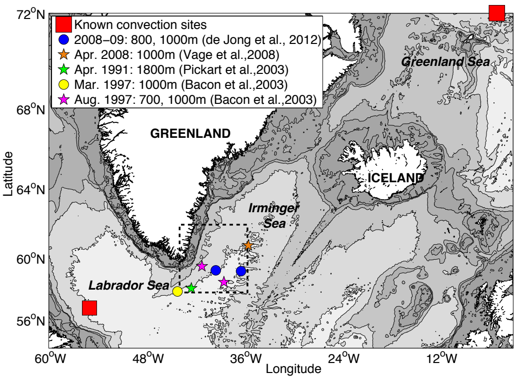
Context and Argo Data

The 2011-2012 winter deep convection event

Explanation by atmospheric forcings

Interannual variability

Bibliographic context



Convection sites in the North Atlantic Ocean and observations of deep mixed layers in the Irminger Sea

Past observations of convection in the Irminger Sea are **limited in space and time**

- Lack of data, especially during wintertime
- Focus on the Labrador site

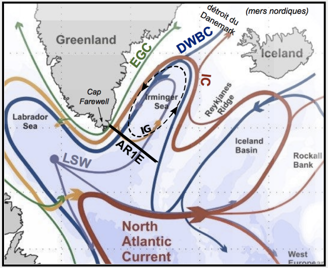
Mechanisms of convection in the Irminger Sea

1. Preconditioning

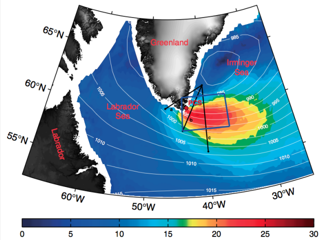
- Cyclonic circulation : Irminger Gyre [Lavender et al., 2000]
- Isopycnal doming [Pickart et al., 2003]
- LSW in the Irminger intermediate layers [Pickart et al., 2003]

2. Atmospheric forcings : Greenland Tip Jets

- regional-scale atmospheric events
- high wind speed (westerly)
- duration < 1 day
- induce heat loss (1000 $W.m^{-2}$ locally)



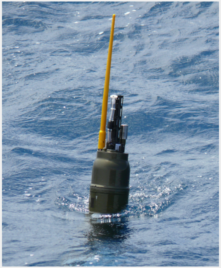
North Atlantic circulation [P. Lherminier, LPO]

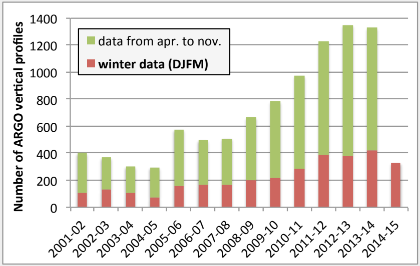


Mean (1999-2002) Tip Jet QuikSCAT winds ($m.s^{-1}$)

[Vage et al., 2009] ; Blue box : 'TJ box'

Argo profiles in the Irminger Sea





Between Sept. 2011 and Sept. 2012 :

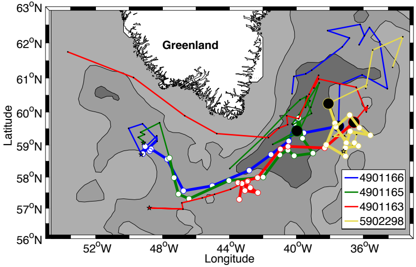
- 1209 vertical profiles from 253 different floats
- 4 floats have particularly been studied (4901163, 4901165, 4901166 and 5902298)
- 1 float with an O_2 sensor during convection

Questions

The Irminger Sea ARGO sampling during the 2011-2012 winter, 3 to 4 times greater than for preceding winters, permit to identify a deep convection event. For this winter, thanks to the ARGO data, we now have informations about the ocean AT BASIN SCALE, DURING the convection event.

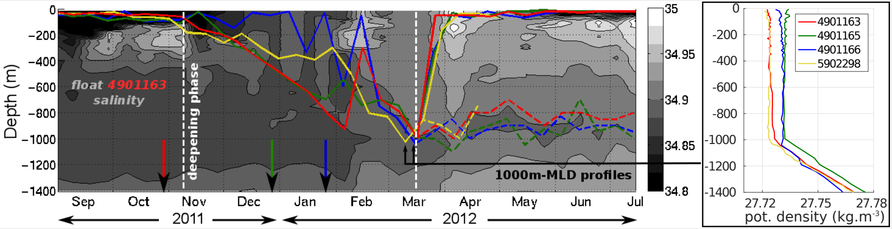
- What is the spatial extent of deep convection in the Irminger Sea ?
- Can we identify the sequence of atmospheric forcings responsible for convection ?
- Can we use the 2011-2012 event to have a better understanding of the past events that could not be observed because of the lack of data ?

Deepening of the mixed layers along floats trajectories

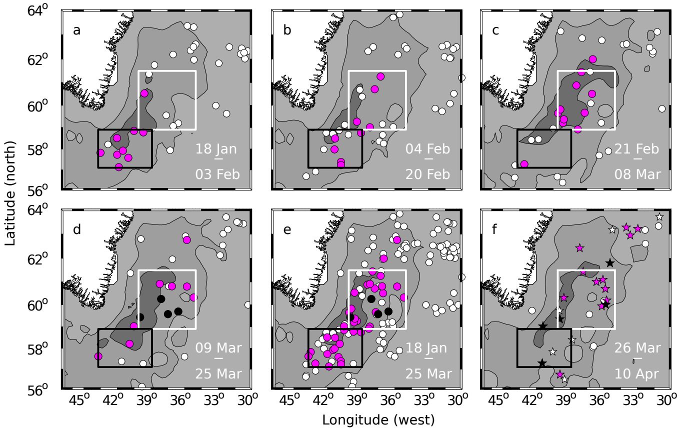


WHITE dots :
floats positions during the deepening phase

BLACK dots :
1000m-MLD positions

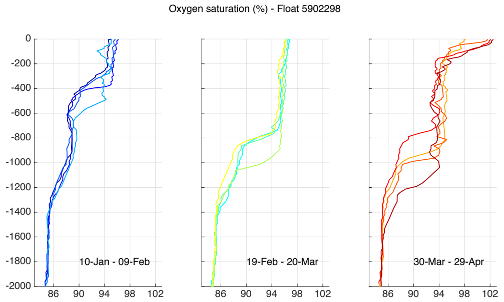


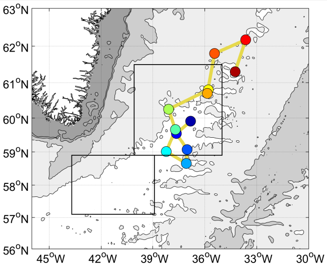
Spatial extent of the convection



***Symbols** : MLD (white : $<$ 680m - magenta : $\geq$ 680m - black : $\approx$ 1000m)*
***Shade** : dynamic topography (contours : -65, -55cm)*
***Boxes** : convection areas (white : north box - black : south box)*

Local formation of the convection



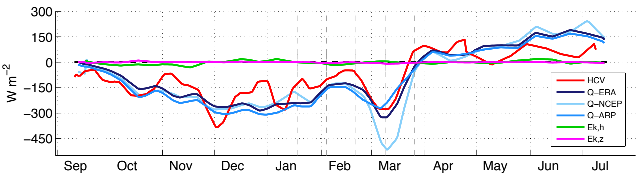


Oxygen data of 5902298 float show that convection occurs **locally** in the Irminger Sea

Heat bugdet along floats trajectories

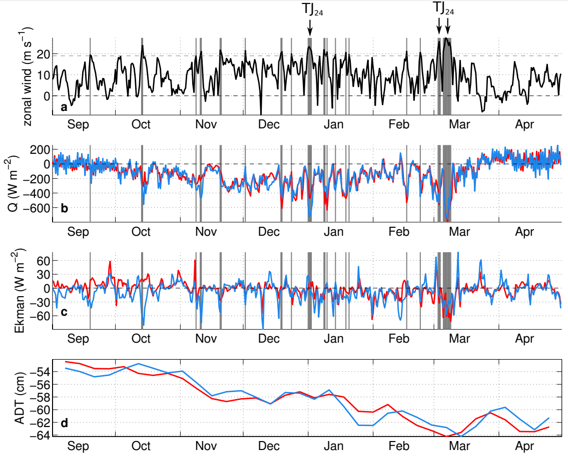
Equation of heat budget [de Boisséson et al., 2010]

$$h\delta_t < T > = \frac{F_{net}}{\rho_0 C_P} - U_{Ek}\delta_x T - V_{Ek}\delta_y T - [< T > - T(-h)]w_{Ek}$$



- Air-sea heat flux explain most of the mixed layer heat variation
- Ekman terms are lower by one order of magnitude than air-sea heat flux
- Heat losses are exceptionally strong early March

Winter 2011-2012 Greenland Tip Jets



Black curves : TJ box

Red curves : north box

Blue curves : south box

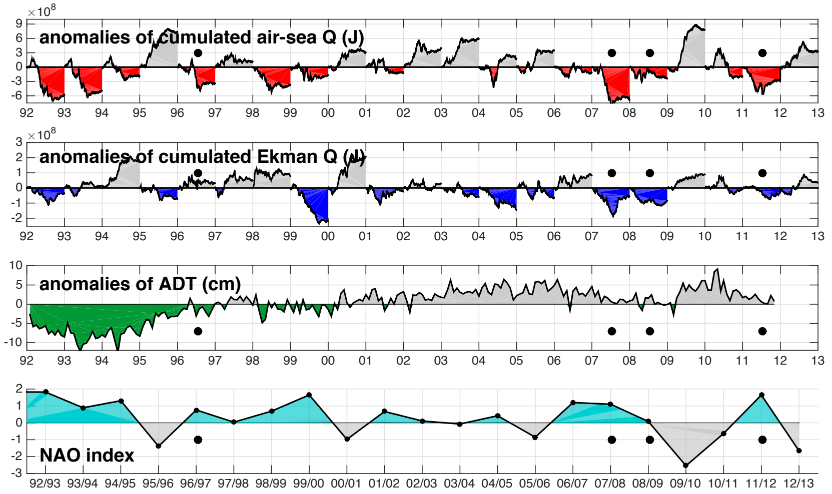
Tip Jet criterion

zonal wind > 19 $m.s^{-1}$

Winter 2011-2012 inventory :

- Total : 18 TJ (Sep. - Mar.)
- 3 longer than a day
- 2 very exceptional early March

Back to the early 1990s...



Conclusions

- Thanks to ARGO data, it is the first observation of Irminger Sea deep convection, at basin scale and during the whole period of convection
- Convection zone located east and south of Cap Farewell
- Deepening (2 months) : firstly progressive, then interrupted (Feb.), and finally strongly restarted bringing ML at 1000m. Fast restratification
- Heat budget along floats trajectories : air-sea Q are mainly responsible for the ML heat content variation
- Late intense TJ early March deepened the MLs up to 1000m. Without these late TJ, MLs would probably not reach 1000m and convection would have stopped in February : so, finally a local small-scale atmospheric event has influence on a larger scale oceanic event
- The effect of Ekman advection is not negligeable : its contribution can reach 10% of the total heat loss
- NAO, Ekman, Q, cyclonic circulation : indicators of deep convection for the Irminger Sea, for past years that have no observation

Reference : **Piron et al., 2015 (submitted in DSR1)**

THANK YOU !

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