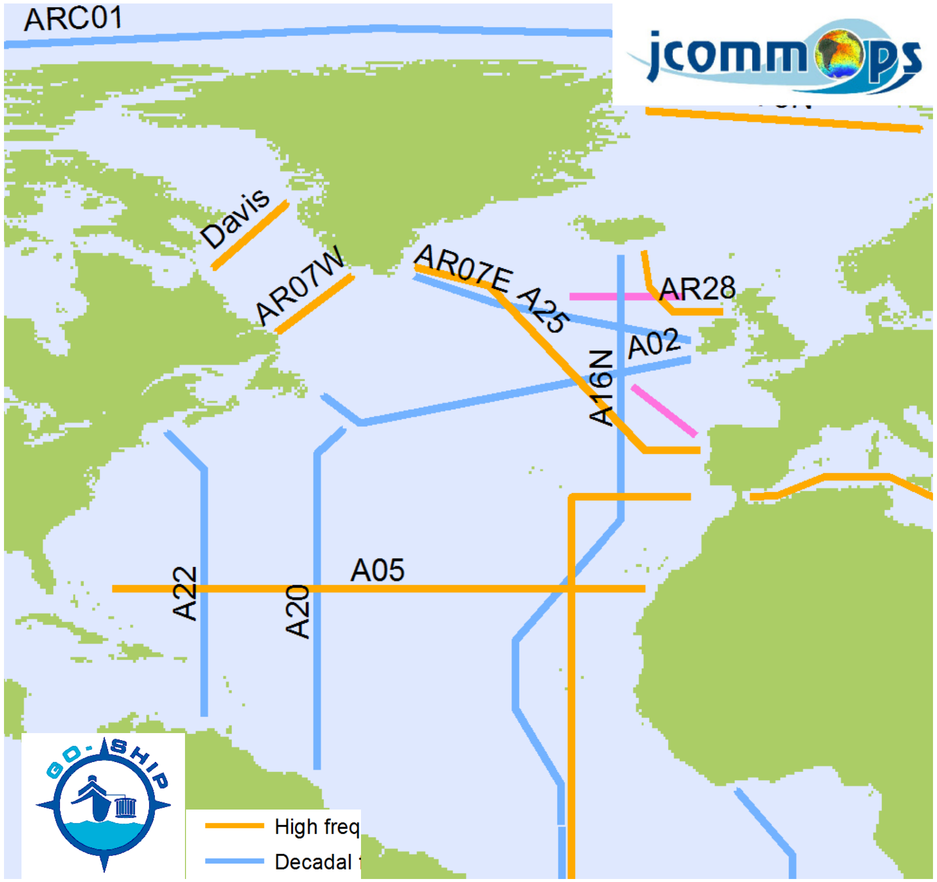
OVIDE

Overview of the main scientific findings about the variability of the meridional overturning circulation and its impact on the CO2 physical pump

Herlé Mercier, P. Lherminier, N. Daniault, F. F. Pérez, P. Zunino, M. I. García-Ibáñez, A. Sarafanov, F. Gaillard, P. Morin, A. F. Rios, D. Desbruyères, A. Falina, B. Ferron, T. Huck, V. Thierry

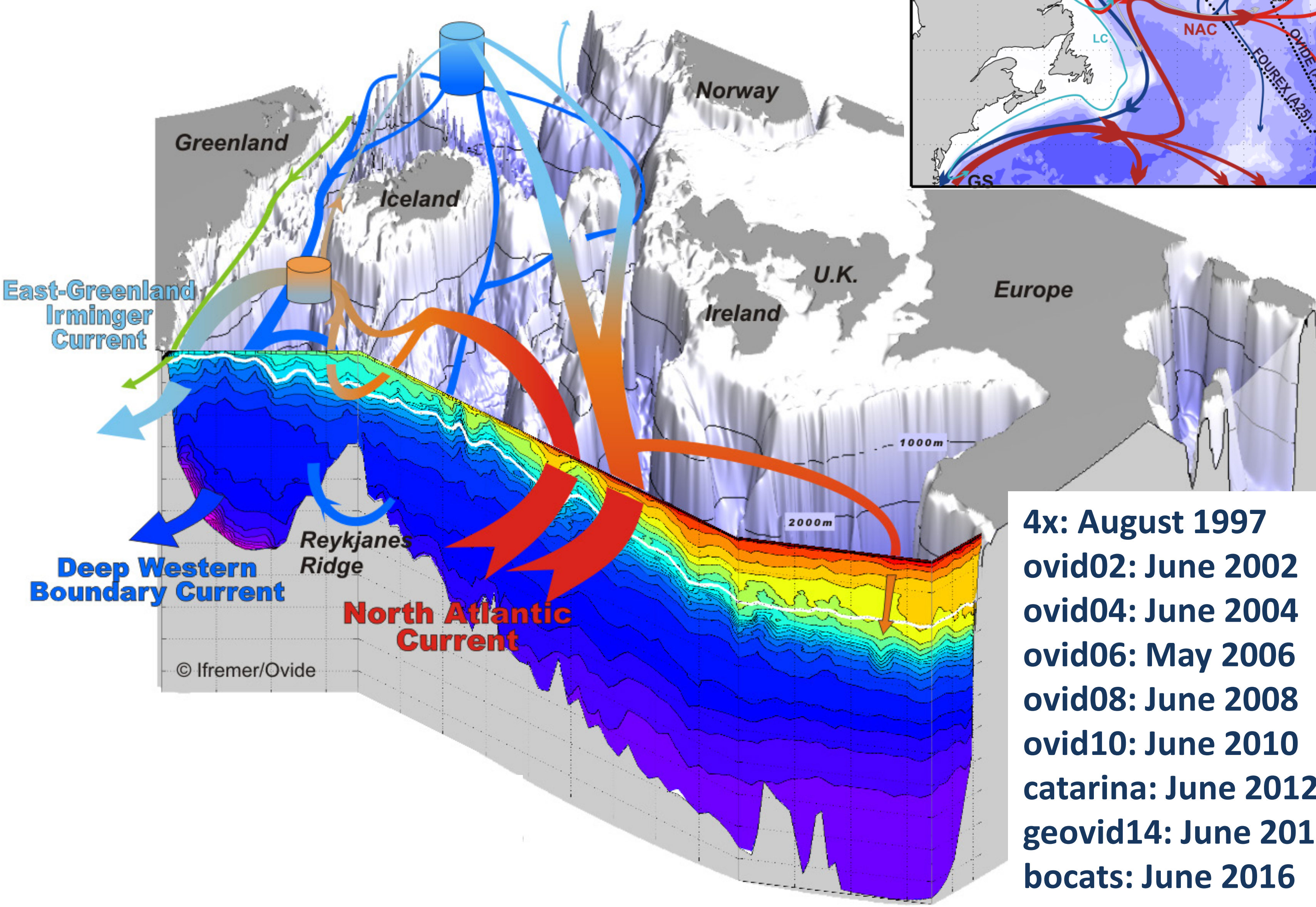
An international context

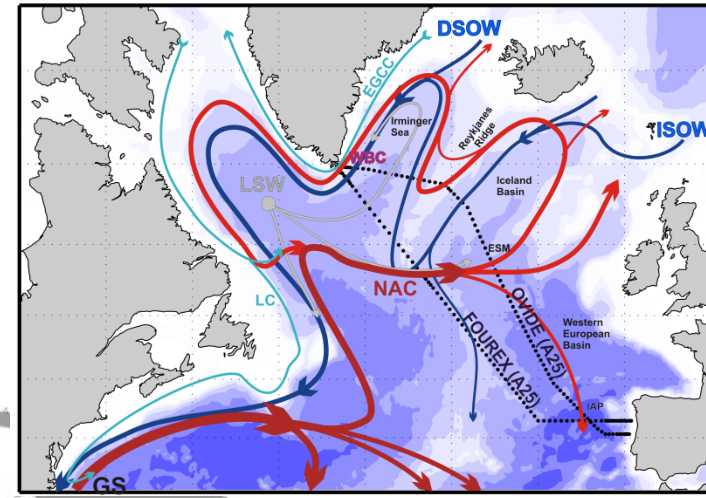


OVIDE-A25 =

- One of the GO-SHIP high-resolution sections in the North Atlantic since 2002
- Physical and biogeochemical data
- Conducted by France (2002-2010) and Spain/France alternatively since 2012
- Contribution to CLIVAR & OSNAP

Why this particular section?





4x: August 1997
ovid02: June 2002
ovid04: June 2004
ovid06: May 2006
ovid08: June 2008
ovid10: June 2010
catarina: June 2012
geovid14: June 2014
bocats: June 2016

Four main scientific questions driving the OVIDE project

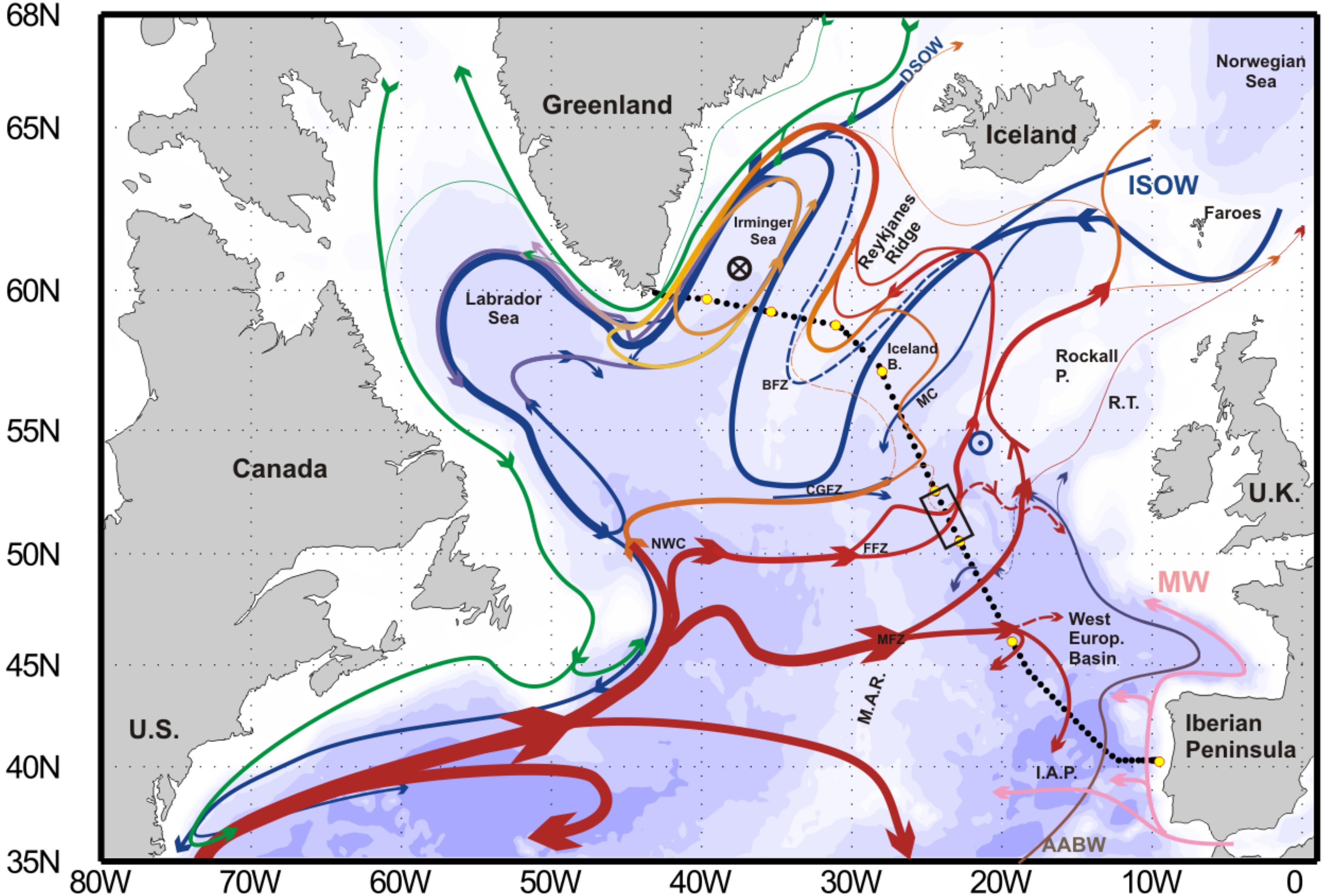
- Quantifying the variability of the Meridional Overturning Circulation (MOC) at subpolar latitudes and explain it

- Elucidate the mecanisms responsible for the storage of anthropogenic carbon dioxyde in the North Atlantic

- Measure the properties of the main water masses and explain their variability in their formation region (SPMW, deep convection in the Irminger Sea)

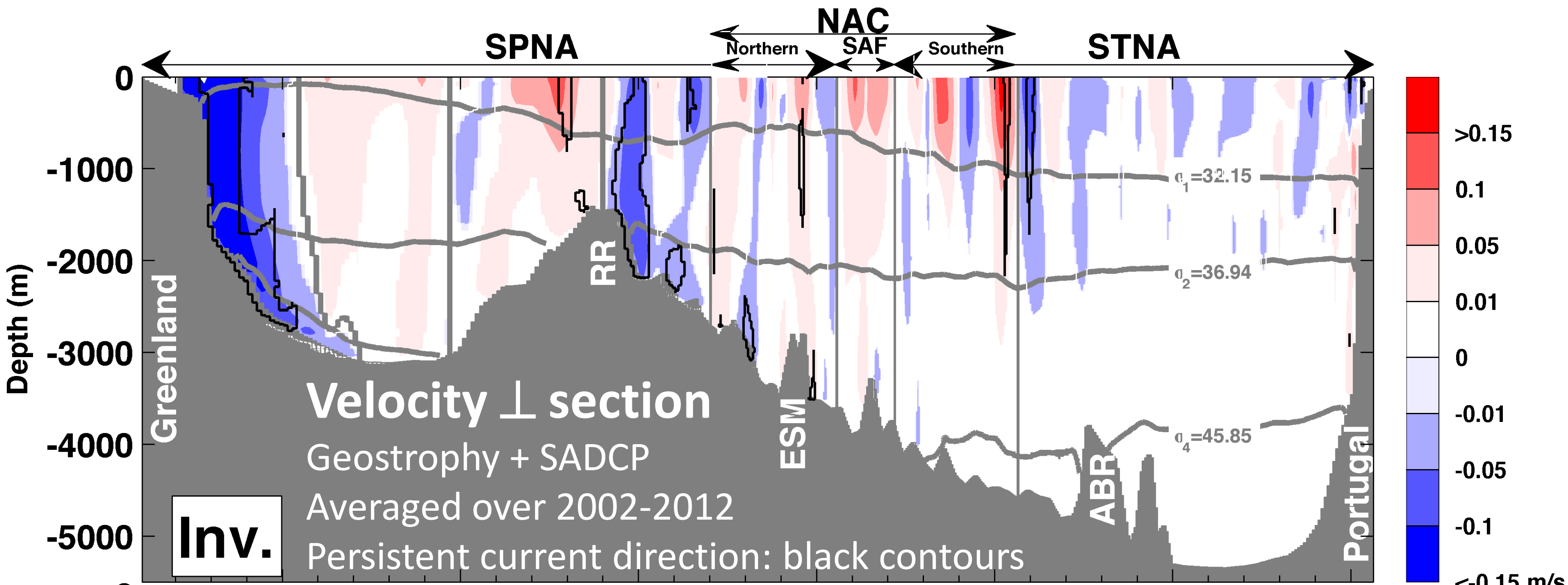
- Directly measure the lower limb of the MOC (deep Argo)

The North Atlantic circulation

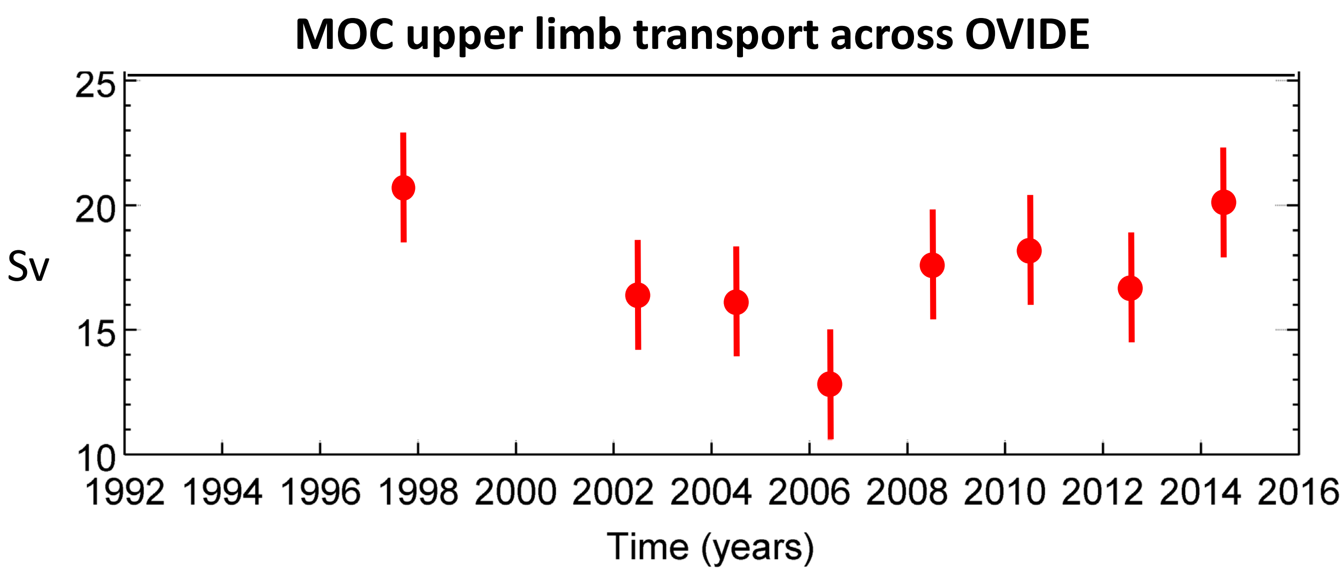


Daniault et al. (2006)

What overturning amplitude did we measure across OVIDE?

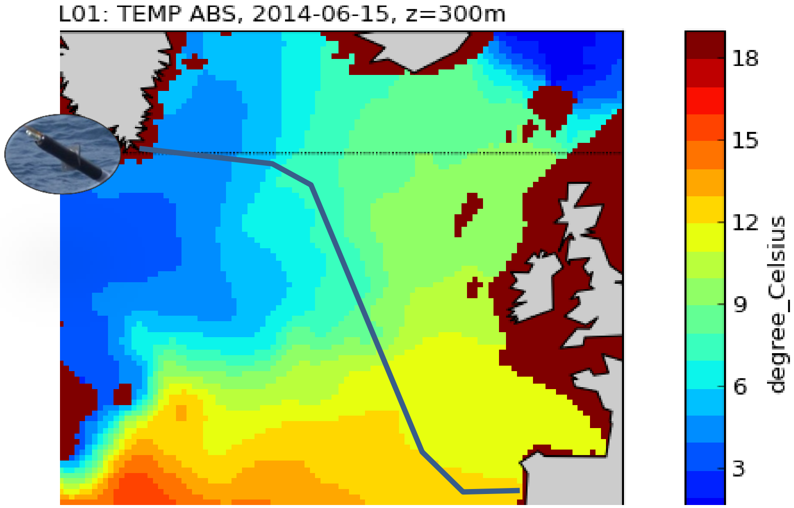


Daniault et al. (2016)



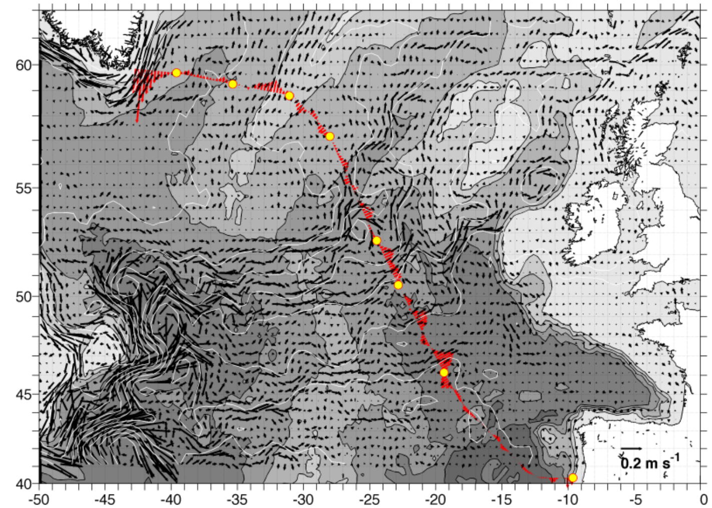
Lherminier et al. (2007, 2010)
Gourcuff et al. (2011)
Mercier et al. (2015)

Reconstructing the AMOC time series



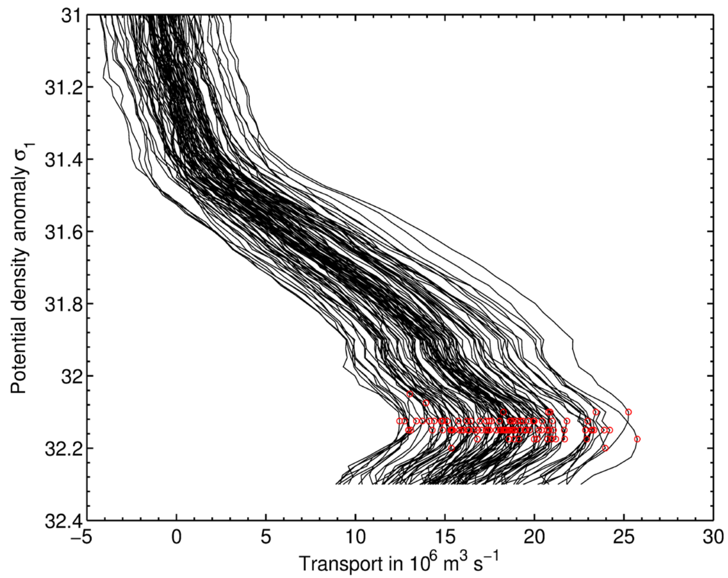
ISAS (Gaillard et al., J. Climate 2016)

+



AVISO surface velocity (Rio and Hernandez, 2004)

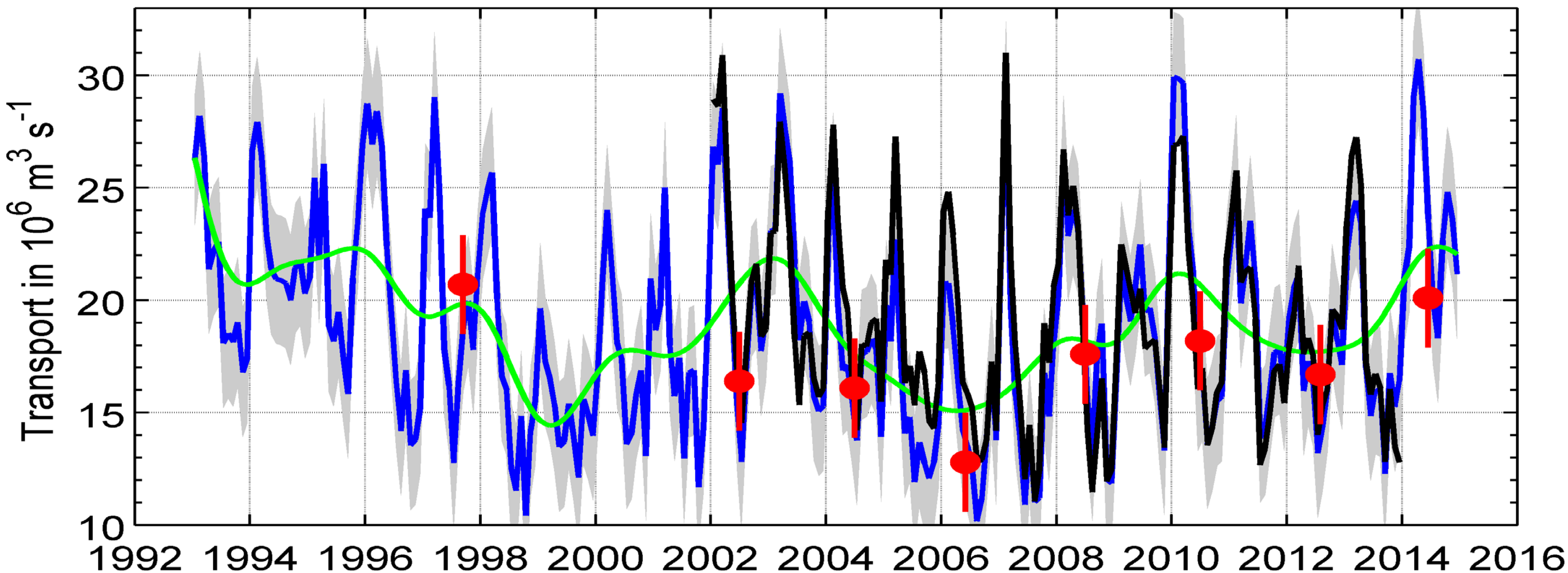
=



MOC upper limb strength estimates every month from velocity integration along isopycnals

Mercier et al. (2015)

MOC timeseries



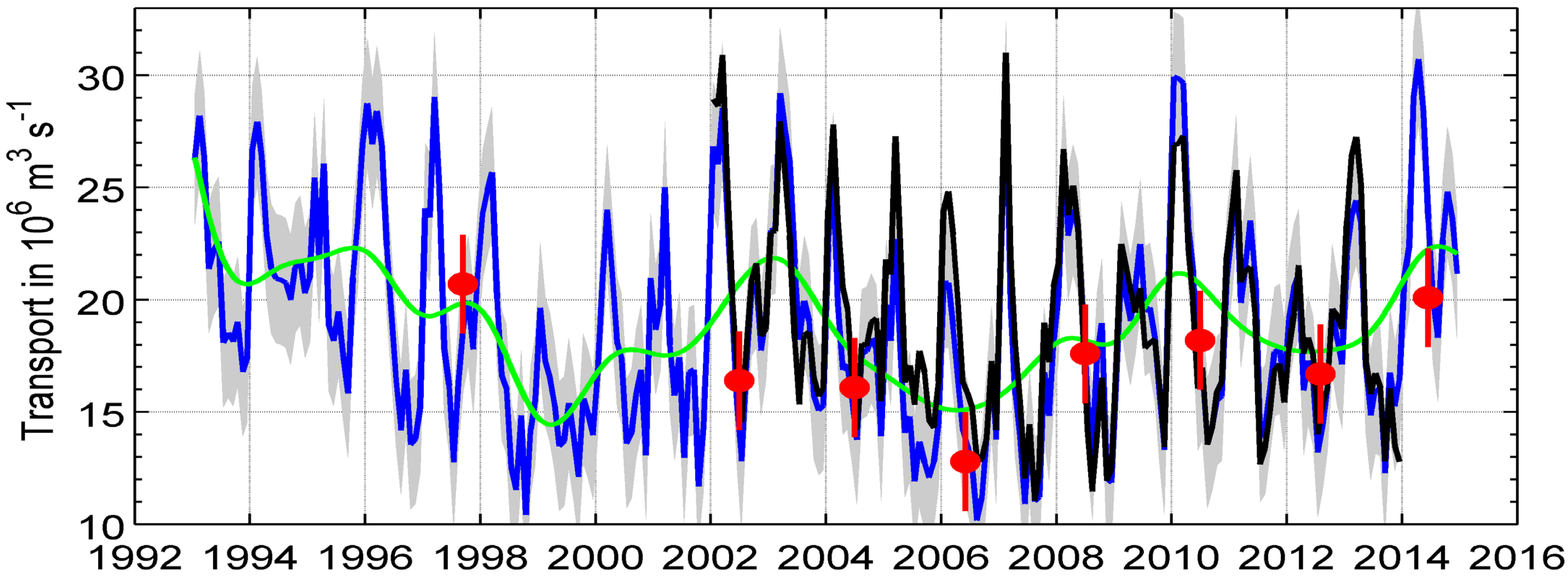
In black: with all the monthly and interannual variability of the ISAS hydrography fields

In blue: with the monthly climatology of the ISAS hydrography fields

In green: with a 24-month low-pass filter

- **The index includes 1 Sv of transport towards the Arctic**
- **The contribution of Ekman transport is about 1 Sv southward**

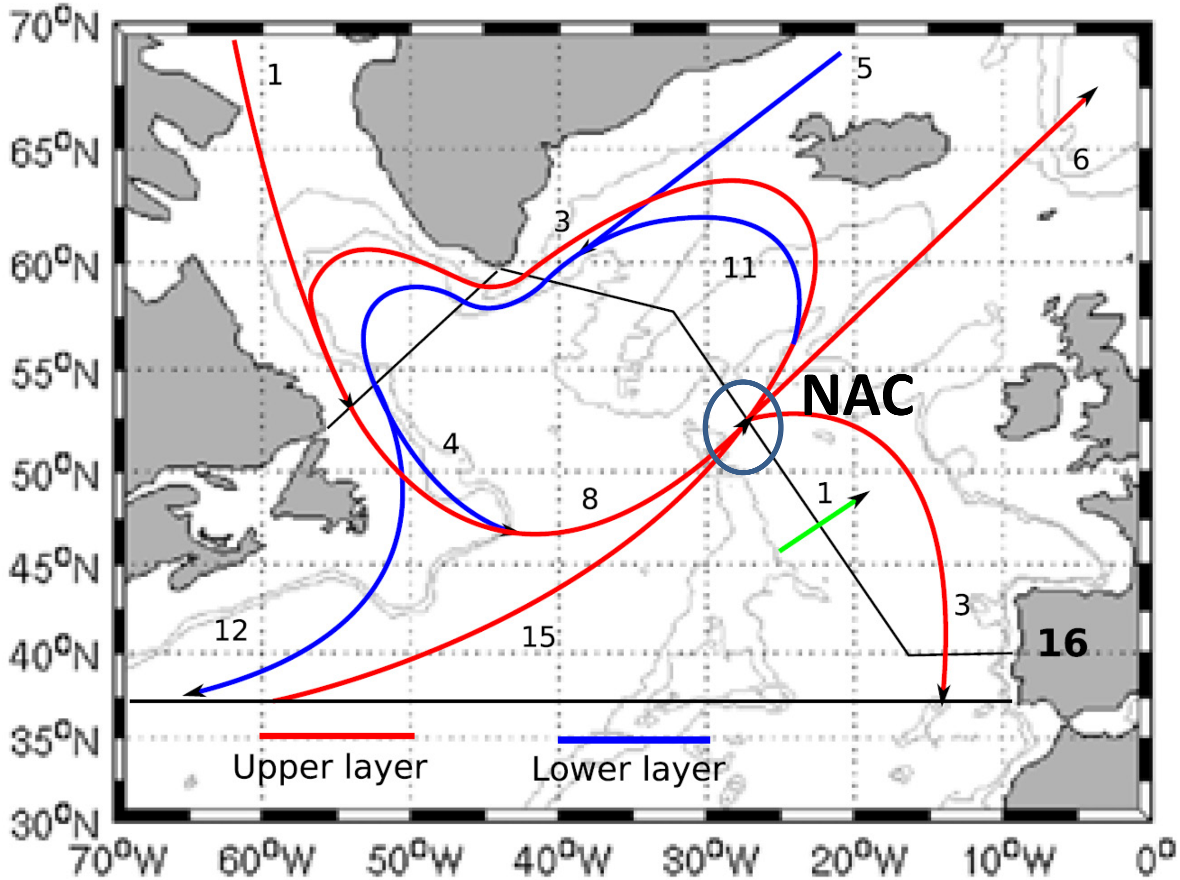
MOC timeseries



In black: with all the monthly and interannual variability of the ISAS hydrography fields
In blue: with the monthly climatology of the ISAS hydrography fields
In green: with a 12-month lowpass filter

- **Labrador Sea contribution is estimated at less than 3 Sv (Pickart and Spall, 2007)**
- **A subpolar gyre internal MOC of about 4 Sv adds to the MOC connected to the subtropical latitudes (Desbruyères et al., 2013)**

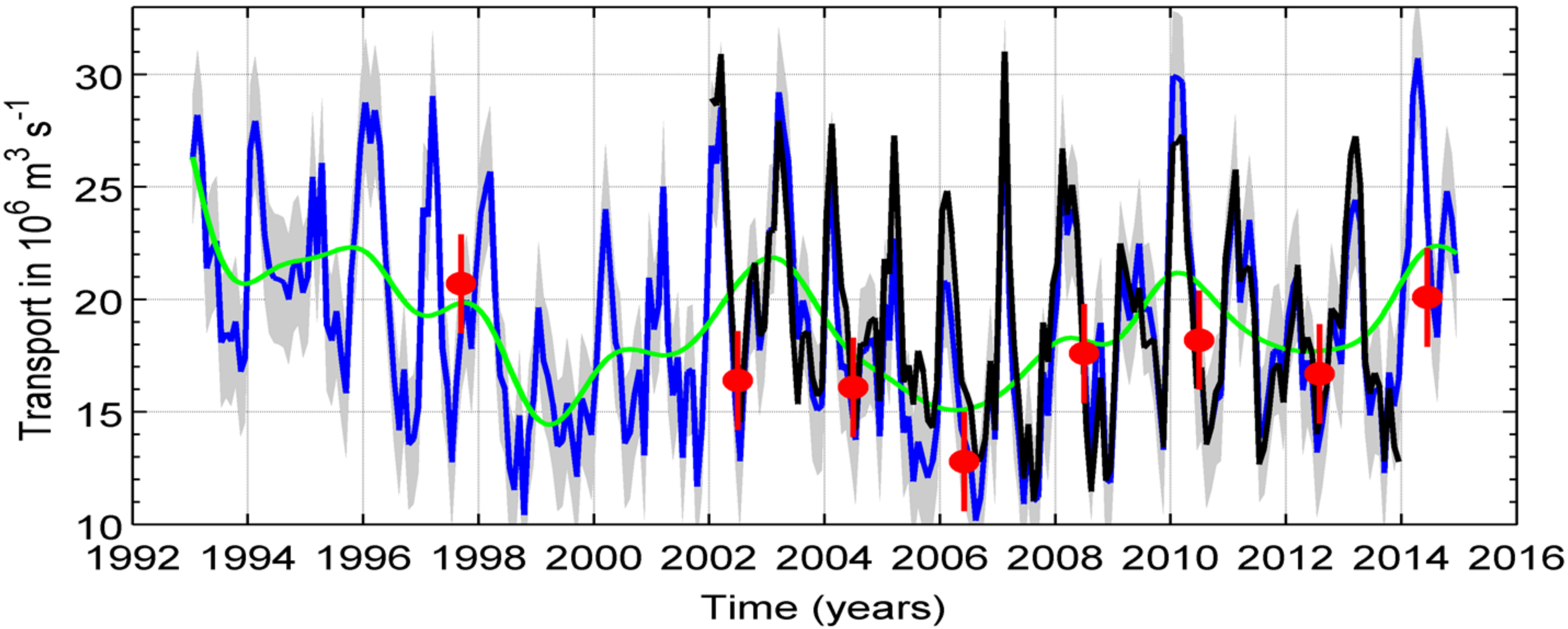
MOC across OVIDE in ORCA025-G70



Desbruyères et al., 2013

Seasonal variability

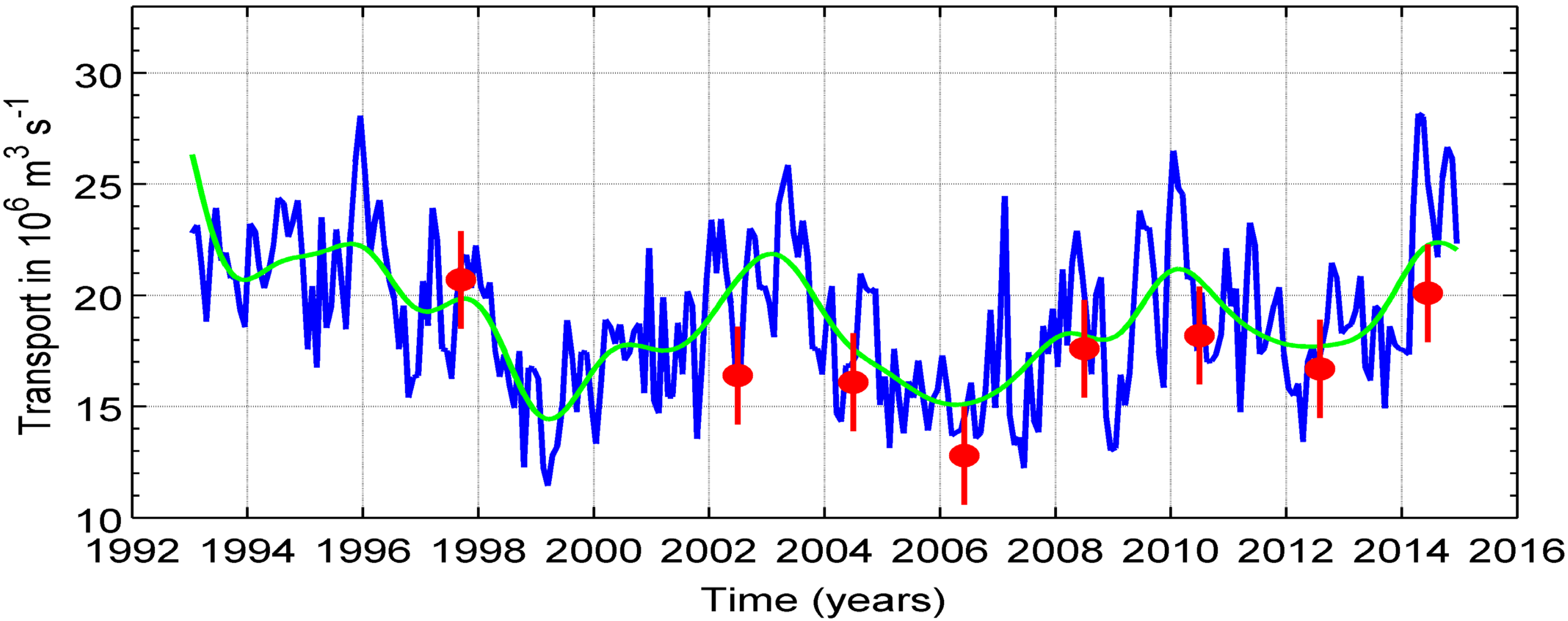
Using an annual mean of the potential density field before integration does not affect the interannual-decadal variability



The seasonal variability is largely controlled by the seasonal density change in σ_{moc} (Daniault et al. in preparation)

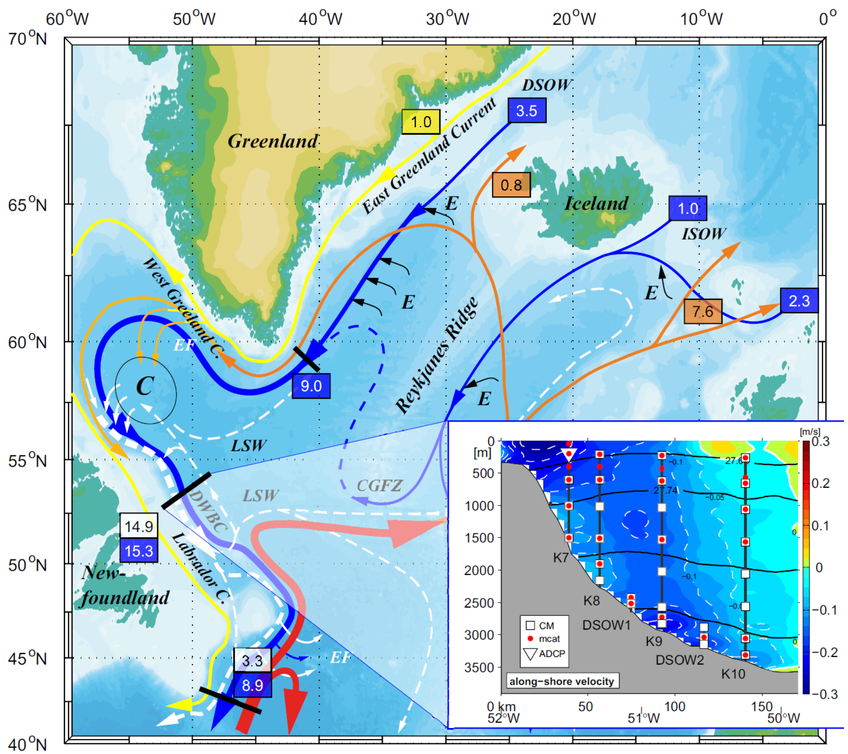
Seasonal variability

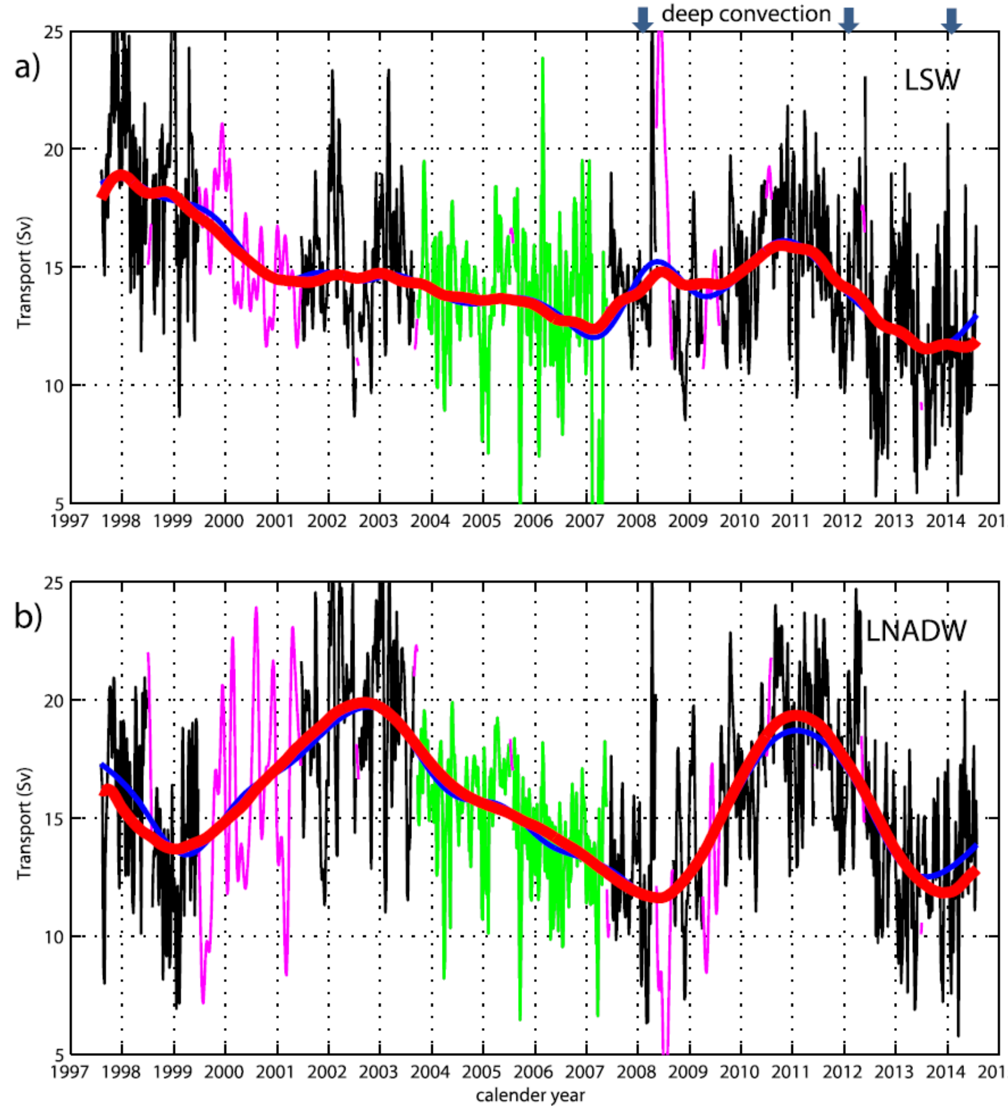
Using an annual mean of the potential density field before integration does not affect the interannual-decadal variability



The seasonal variability is largely controlled by the seasonal density change in σ_{moc} (Daniault et al. in preparation)

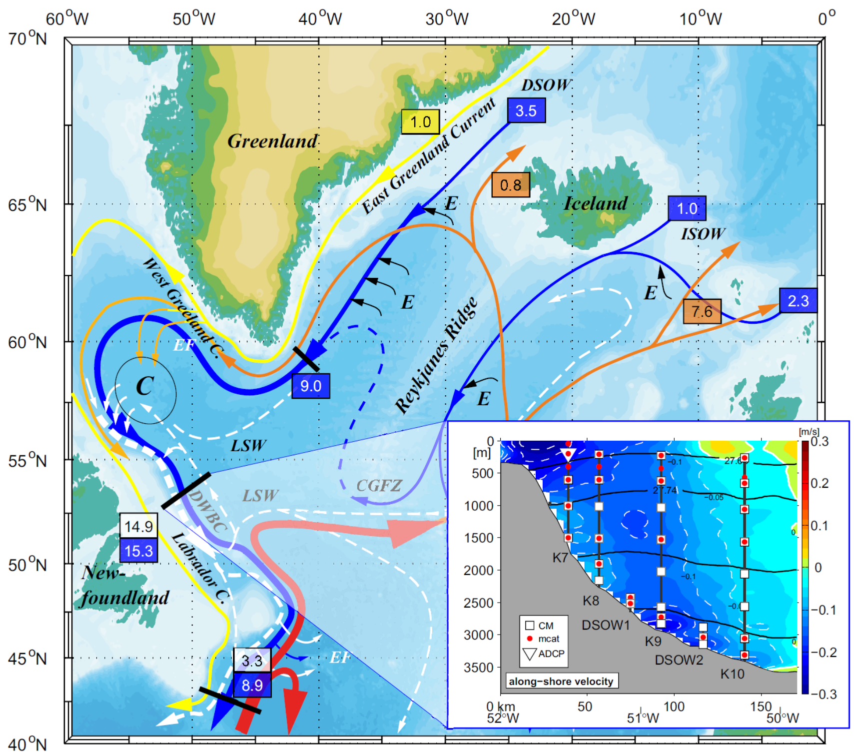
Comparing with AMOC lower limb

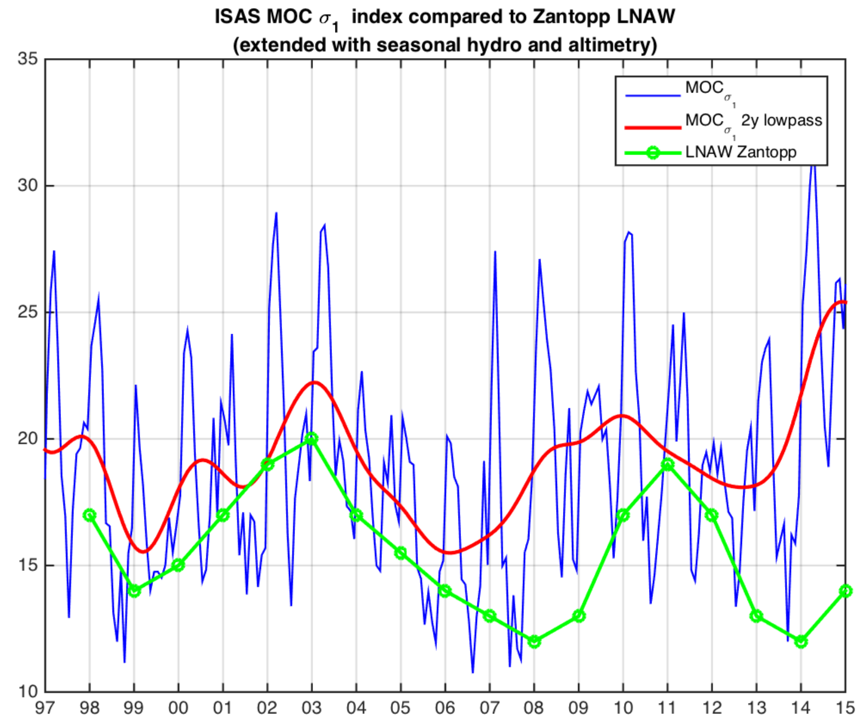




Zantrop et al., 2017

Comparing with AMOC lower limb

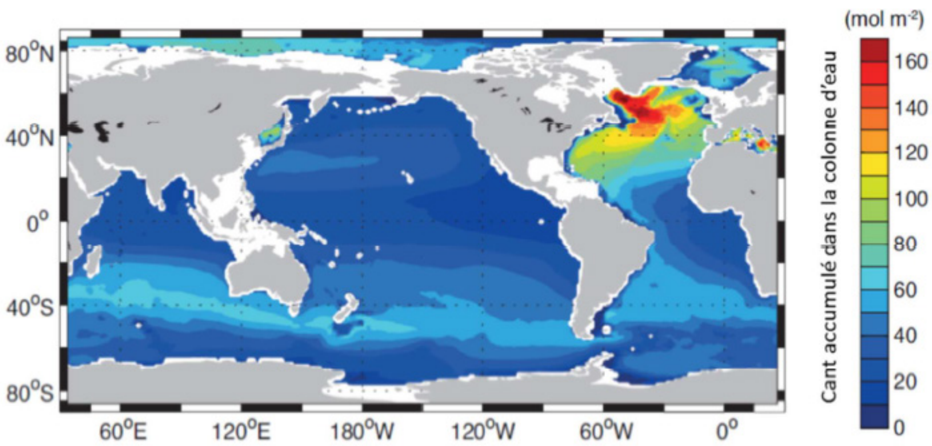




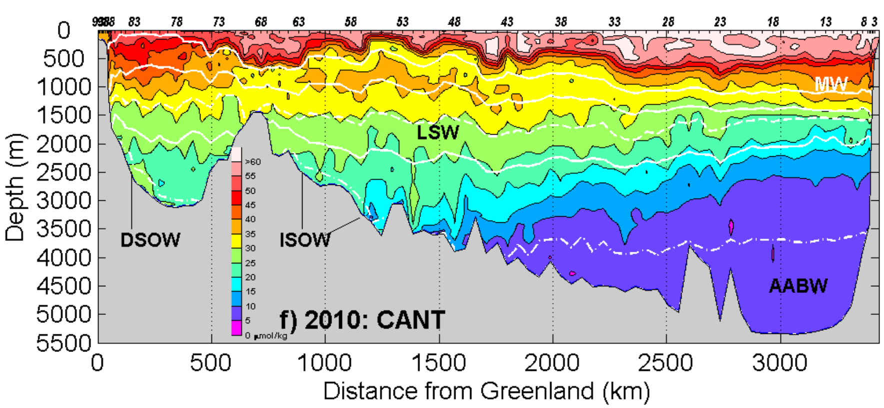
Zantrop et al., 2017

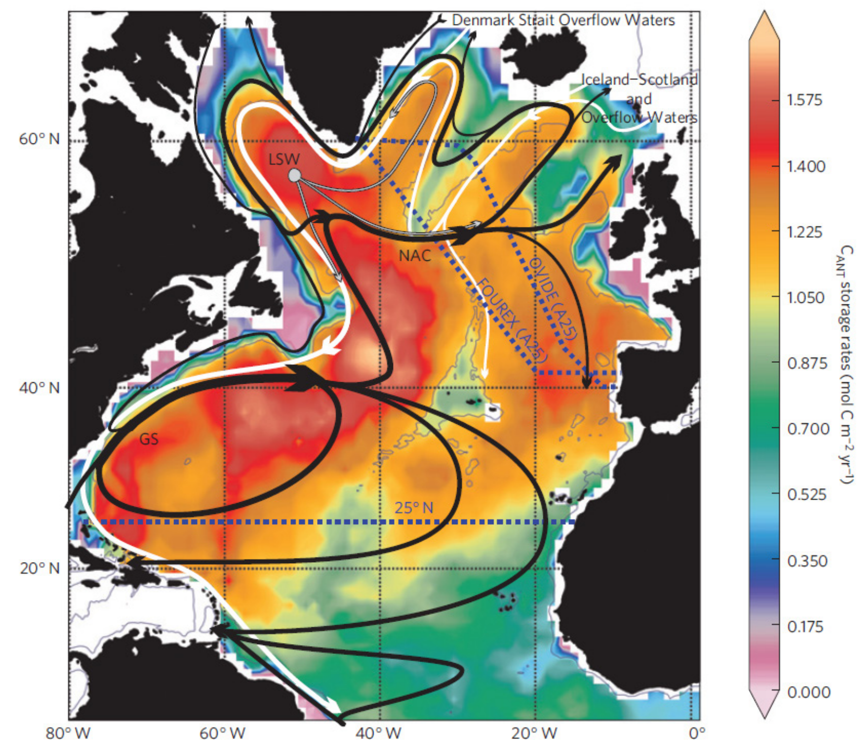
Daniault, pers. comm.
Karstensen et al., in preparation

Anthropogenic CO_2 uptake in subtropical gyre



C_{ant} = Anthropogenic Carbon

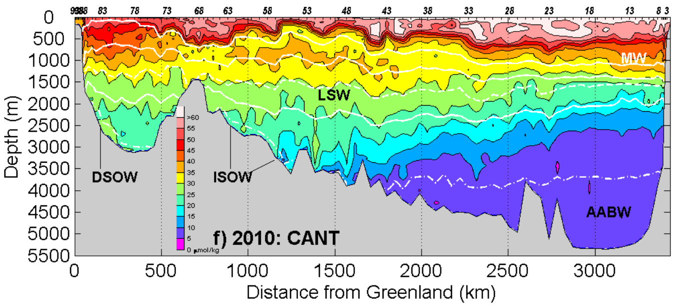




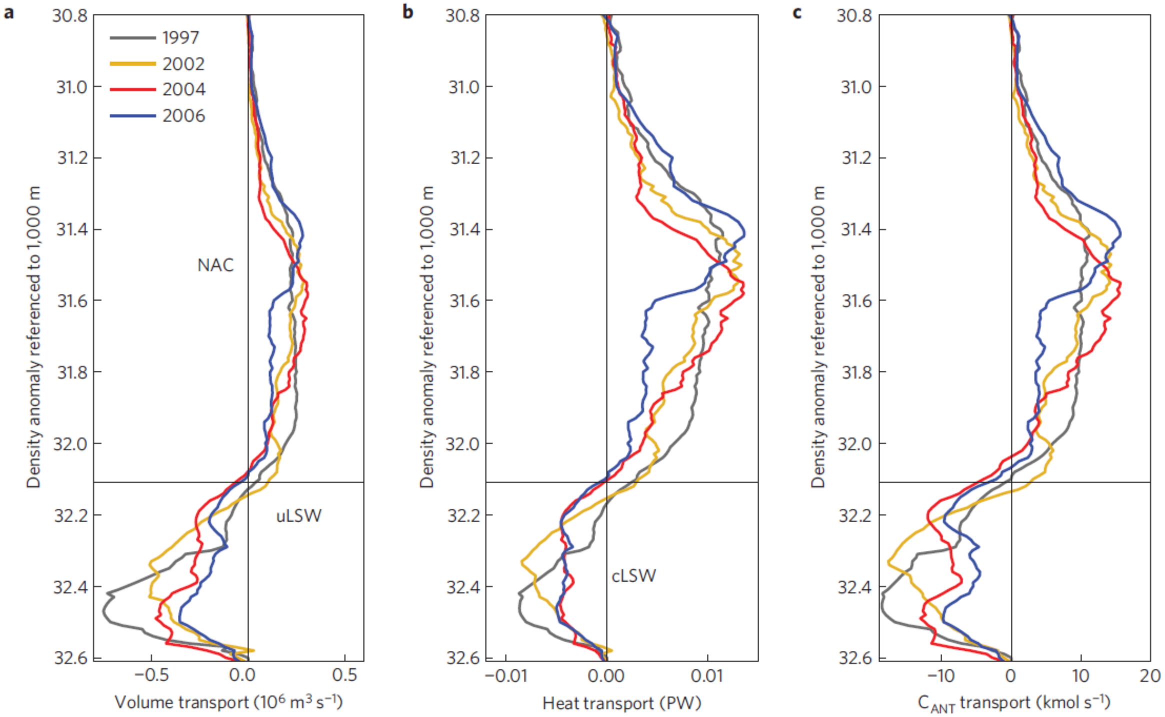
In the NA, Cant uptake occurs in the subtropical gyre (mostly)

Cant storage rate in 2004 from Perez et al. (2013)

Net northward transport of Cant by the MOC



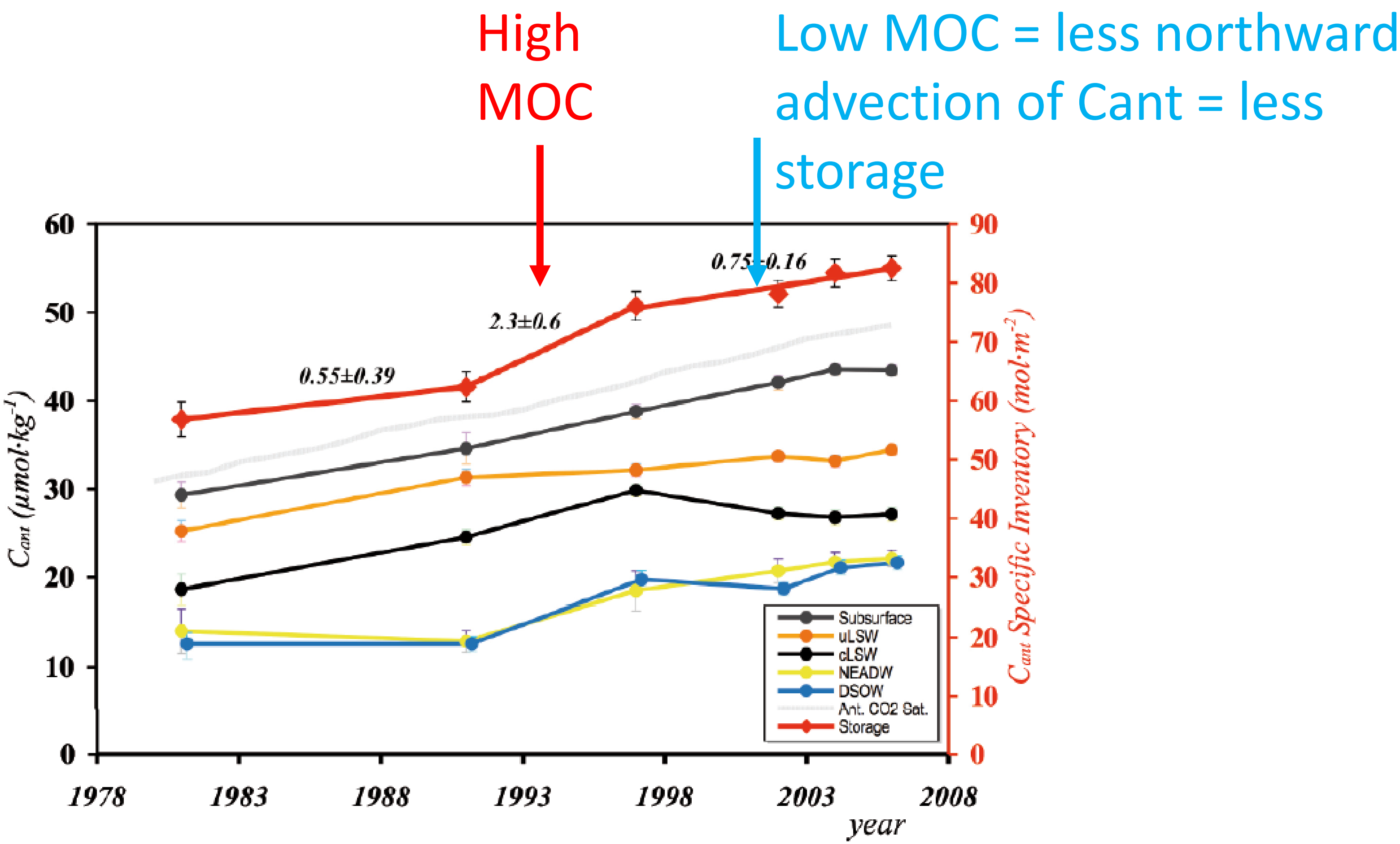
The water masses of the MOC upper (northward) limb show higher Cant than those of the MOC lower (southward) limb.



Volume transport Heat Transport Cant transport

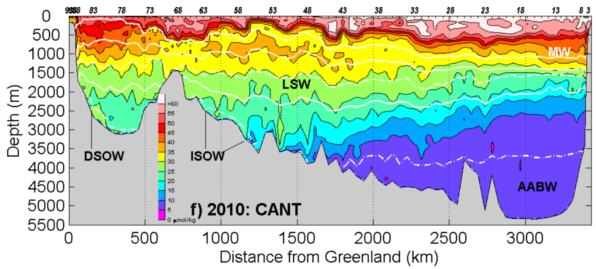
- ❑ The net transport of Cant by the MOC is northward
- ❑ Cant accumulates in the northern North Atlantic because of this net northward transport by the MOC. (Isopycnal circulation contributes little)
- ❑ Perez et al. (2013); Zunino et al. (2014)

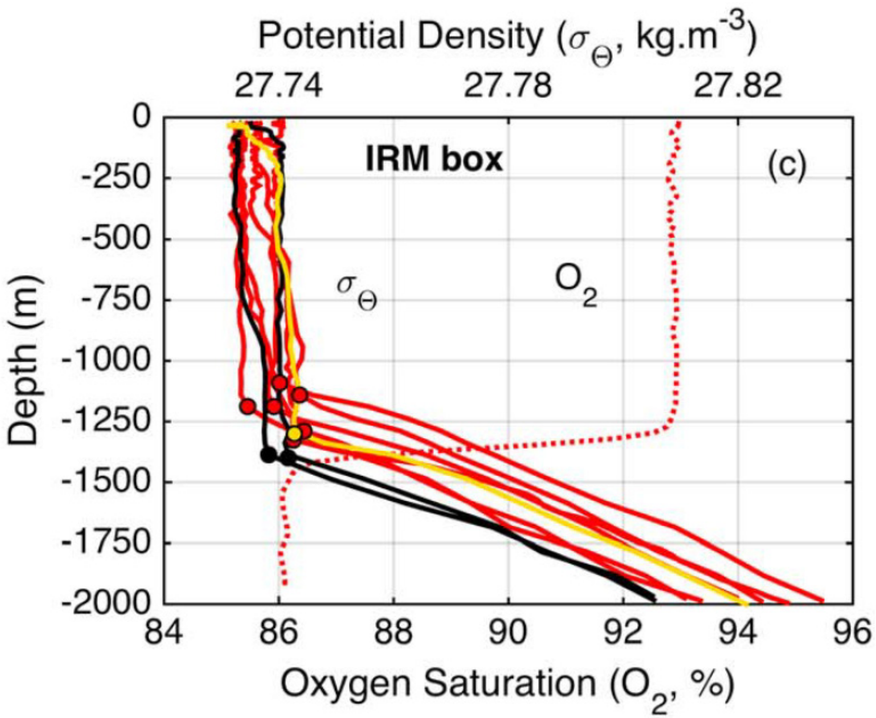
MOC variability and Cant storage rate



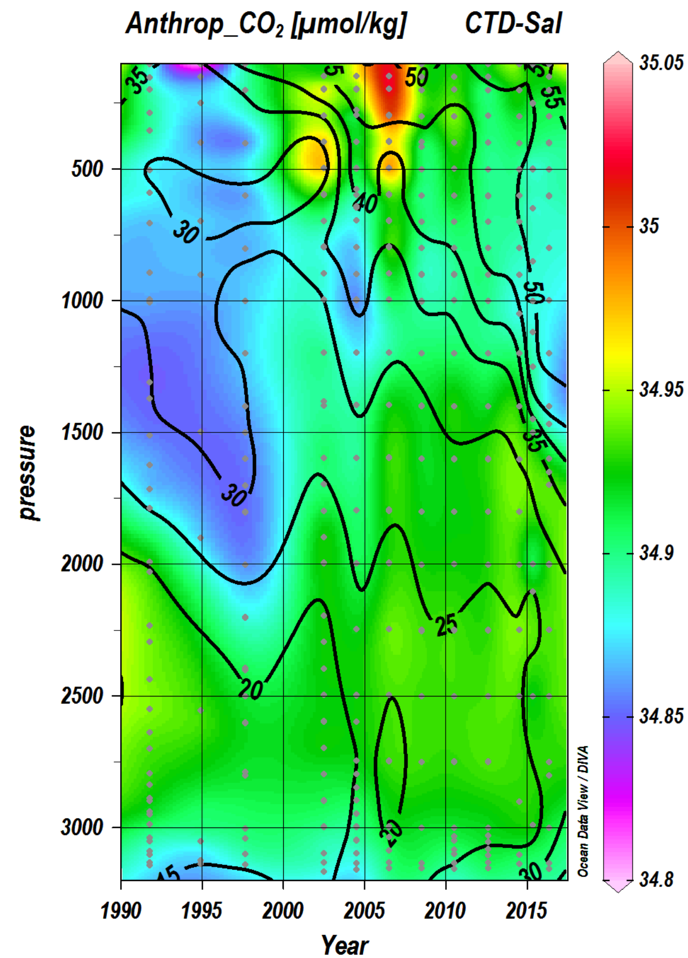
On inter-annual to decadal time scale MOC controls the storage rate of Cant in the North Atlantic subpolar gyre (see Zunino et al. 2014 for longer time scales)

Anthropogenic CO_2 cycle





Exceptionnal deep convection in the Irminger Sea during winter 2014-2015. Piron et al. (2017).



Injection of Cant into the deep ocean by deep convection events (Perez et al, in preparation)

Conclusions

- The upper **MOC_σ time series** reveals a strong seasonal to decadal variability, and a clear correlation with the DWBC array.
- The **MOC_σ recovered** lately from a sluggish 2000s decade (See Patricia Zunino et al. poster)
- Data strengthen the importance of the contrast of **anthropogenic CO_2** concentration between the upper and lower limbs of the MOC_σ for the **understanding the storage rate** in the subpolar North Atlantic
- The MOC_σ variability is important to understand the **interannual variability of anthropogenic CO_2 storage rate**
- Publications: *http://www.umr-lops.fr/Projets/Projets-actifs/OVIDE/Publications*
- Data: Mercier Herle, Daniault Nathalie, Lherminier Pascale (2016). **Time series of the Meridional Overturning Circulation intensity at OVIDE**. SEANOE. http://doi.org/10.17882/46445