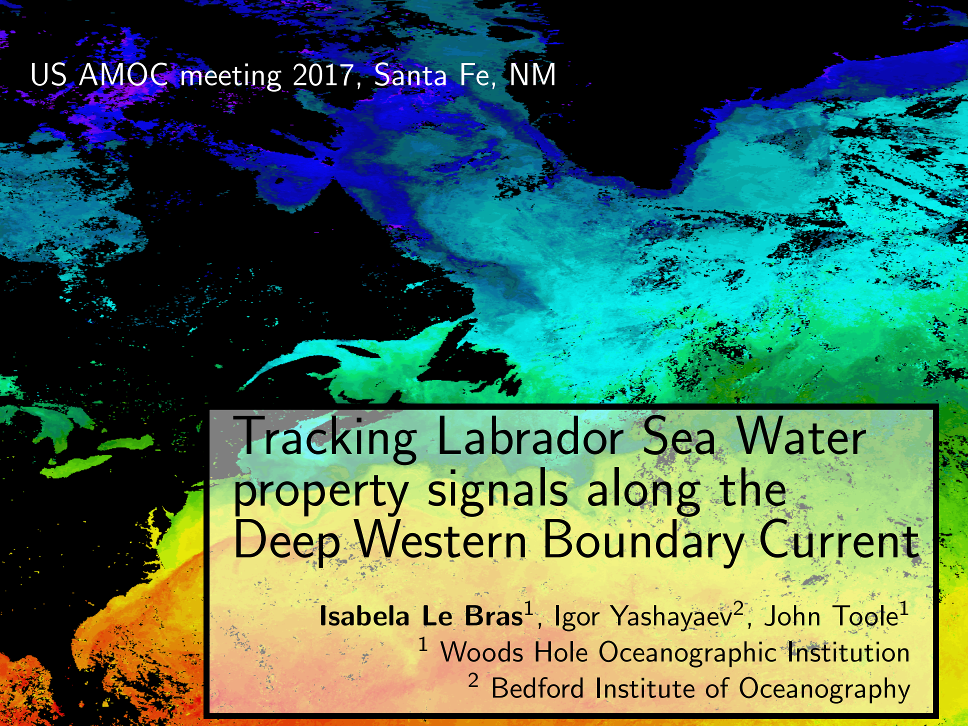
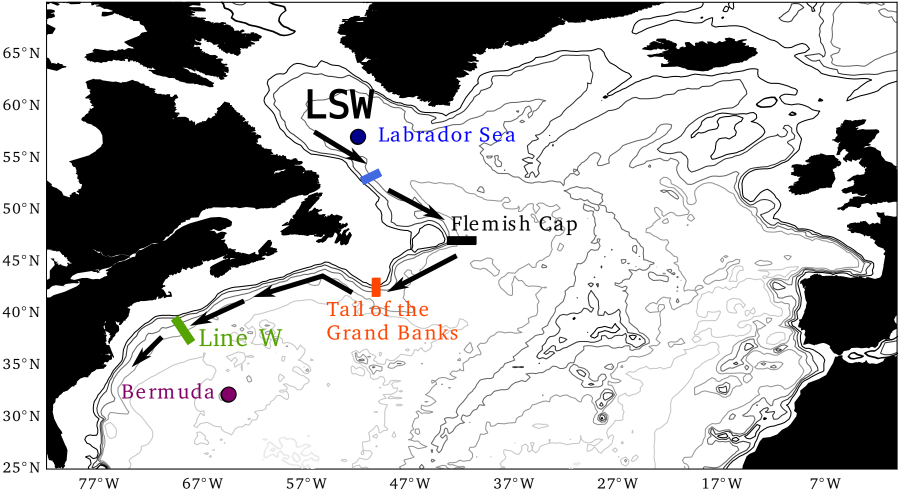


US AMOC meeting 2017, Santa Fe, NM

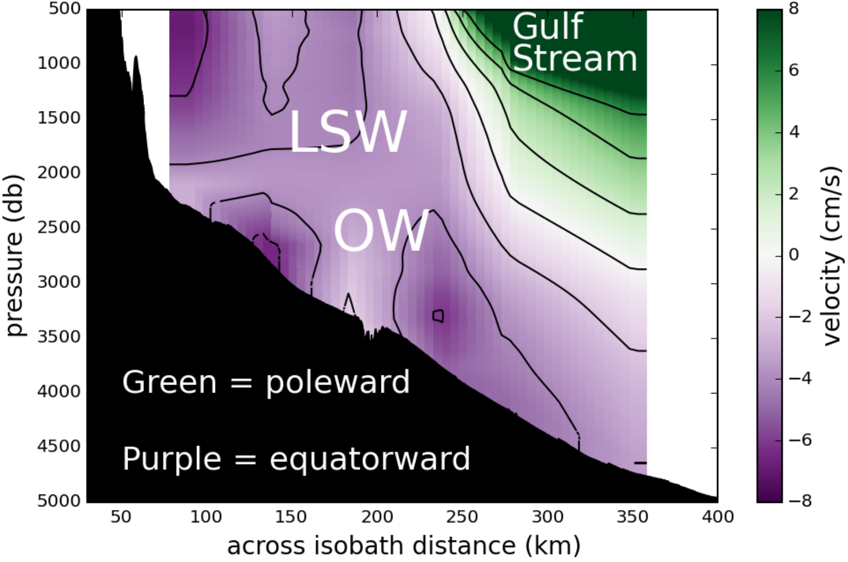
Tracking Labrador Sea Water property signals along the Deep Western Boundary Current

Isabela Le Bras[1], Igor Yashayaev[2], John Toole[1]
[1] Woods Hole Oceanographic Institution
[2] Bedford Institute of Oceanography

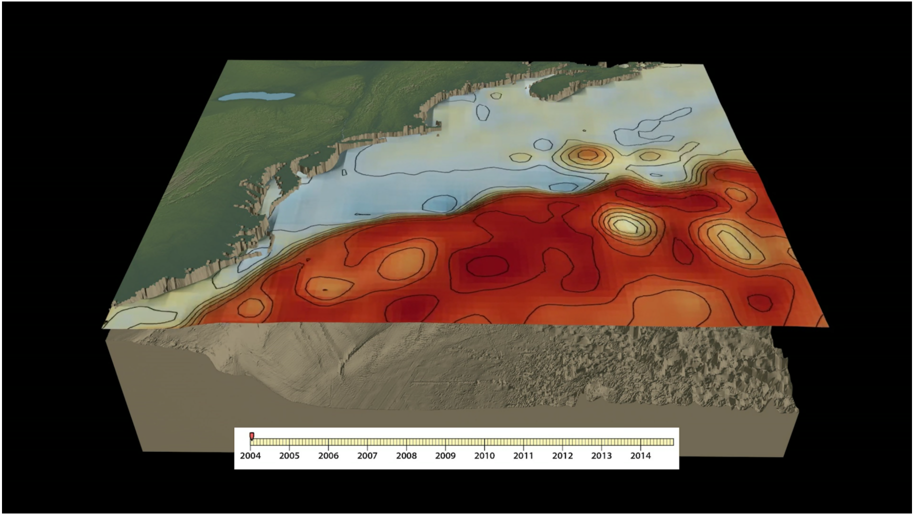
Tracking LSW along the DWBC



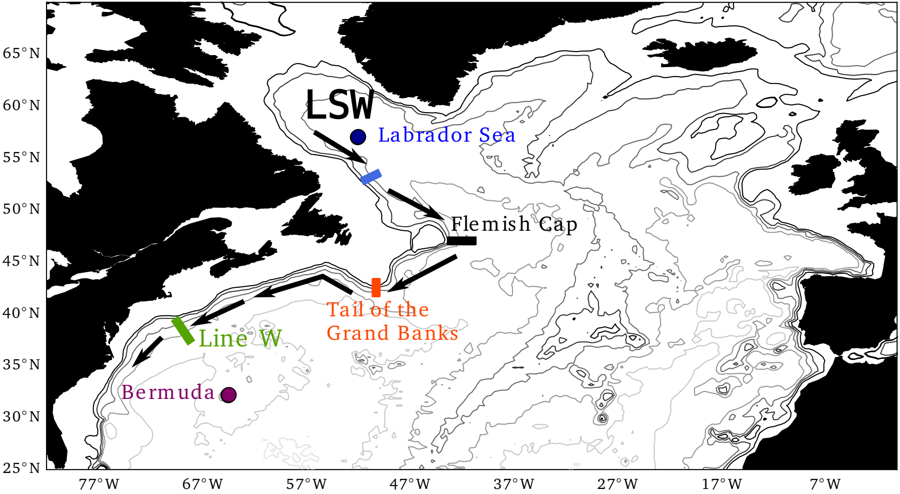
Line W across-array velocity (2004–2014)



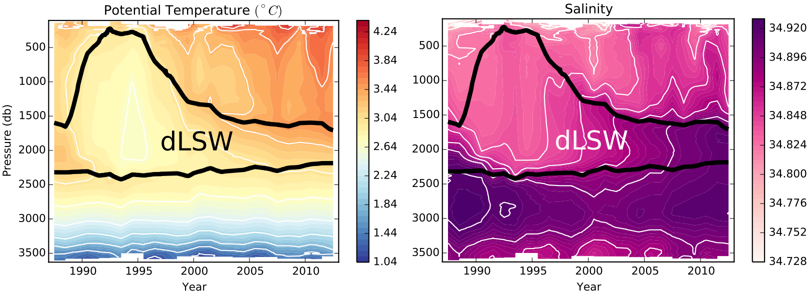
Variability at Line W



To what degree is the spreading of LSW in the DWBC affected by stirring?



Deep Labrador Sea Water production

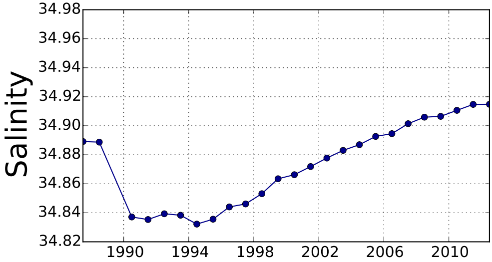


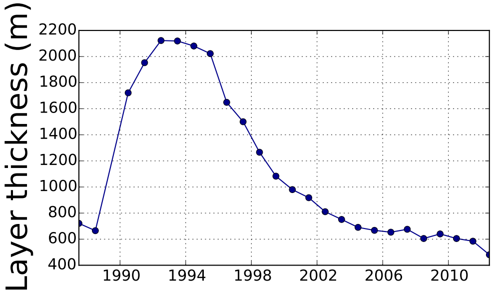
Intense deep convection in the early-mid 90s.

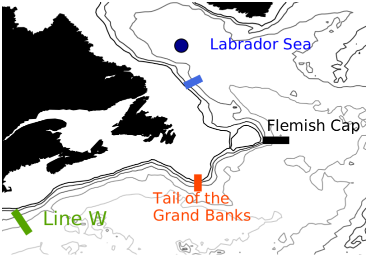
Throughout 2000s layer thins, warms and gets saltier.

(Yashayaev 2007, Kieke and Yashayaev 2015)

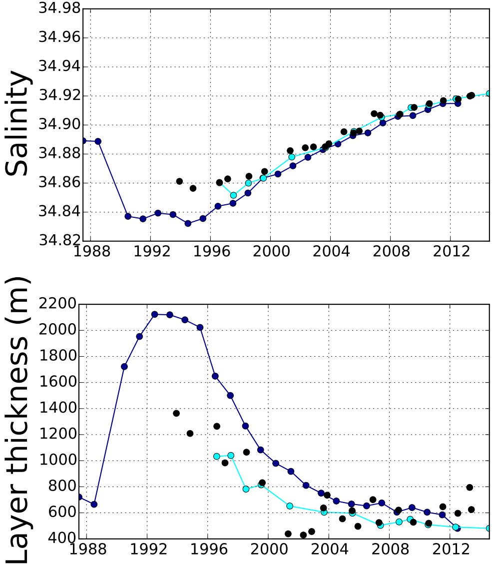
dLSW properties along DWBC path

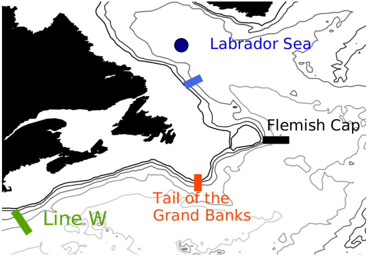






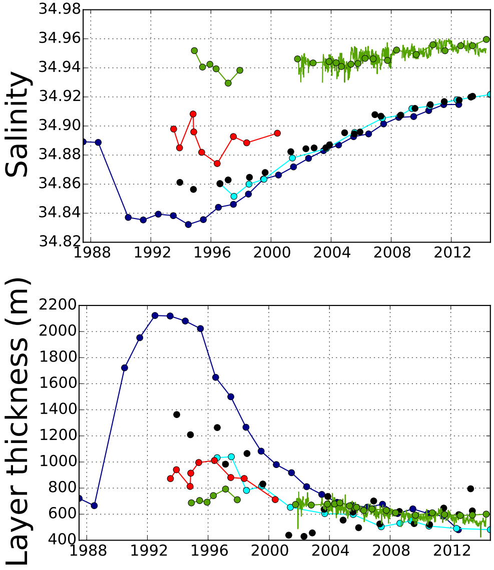
dLSW properties along DWBC path

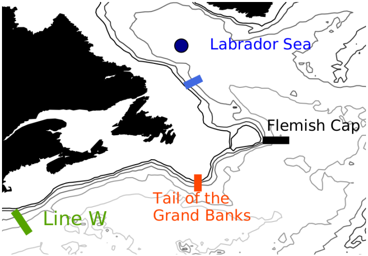




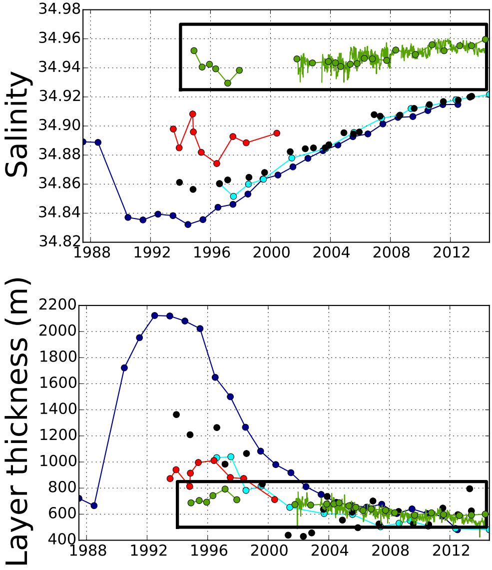
53N: Visbeck, Fischer, Handmann; Flemish Cap: Rhein, Mertens

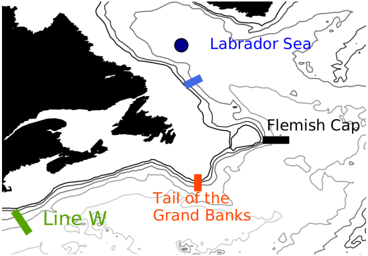
dLSW properties along DWBC path



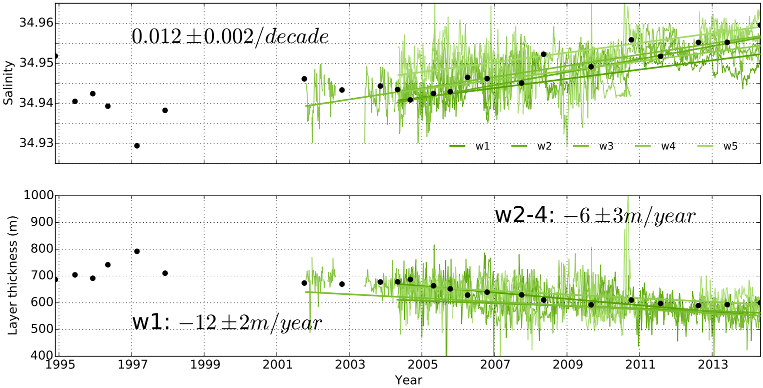


dLSW properties along DWBC path



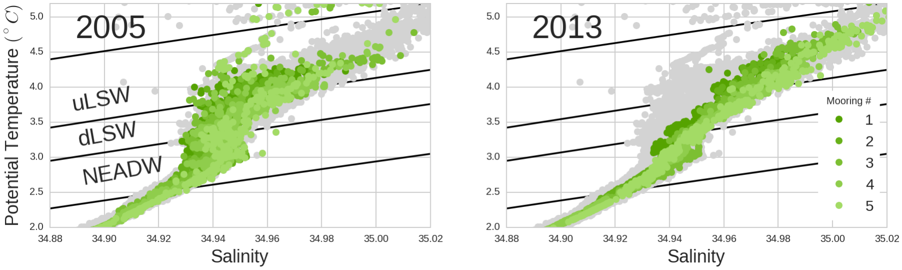


dLSW trends in Line W moorings



$+0.014 \pm 0.02^{\circ}C/year$

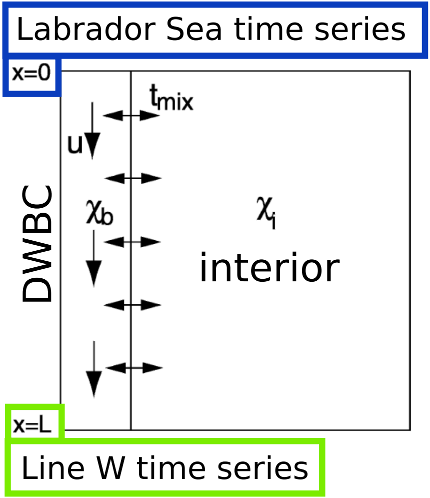
TS property evolution at Line W moorings

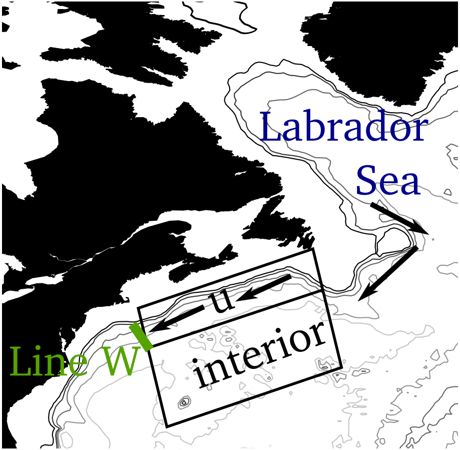


In 2005 TS profiles are broadly distributed in TS space.

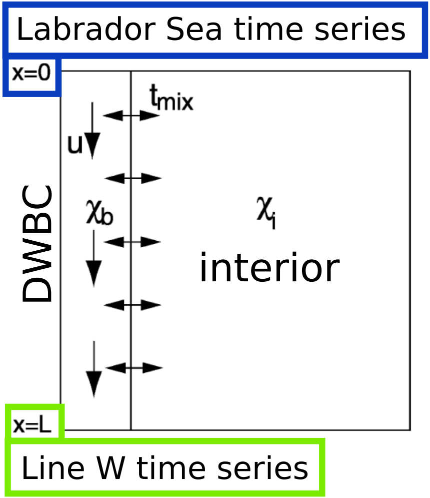
By 2013, the distribution is narrow and lacks signature of especially cold, fresh dLSW

Analytical model to estimate time scales of advection and mixing





Analytical model to estimate time scales of advection and mixing



$$\frac{\partial \chi_b}{\partial t} + u\frac{\partial \chi_b}{\partial x} + \frac{1}{t_{mix}}(\chi_b - \chi_i) = 0$$

$$t_{adv} = L/u$$

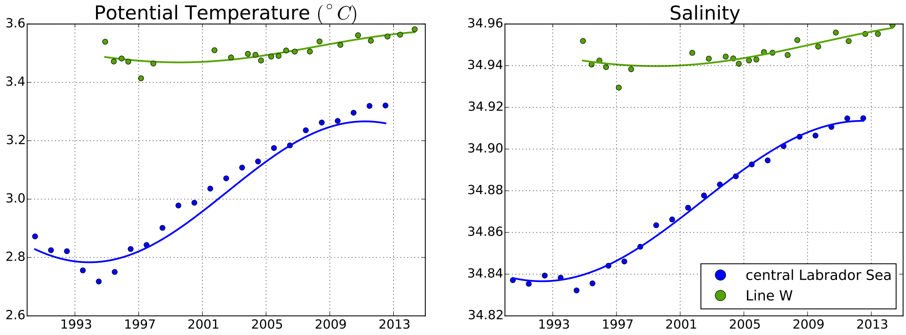
$t_{adv} \gg t_{mix}$: High mixing

$t_{mix} \gg t_{adv}$: Low mixing

Relates to transit time distribution

(Waugh and Hall 2005)

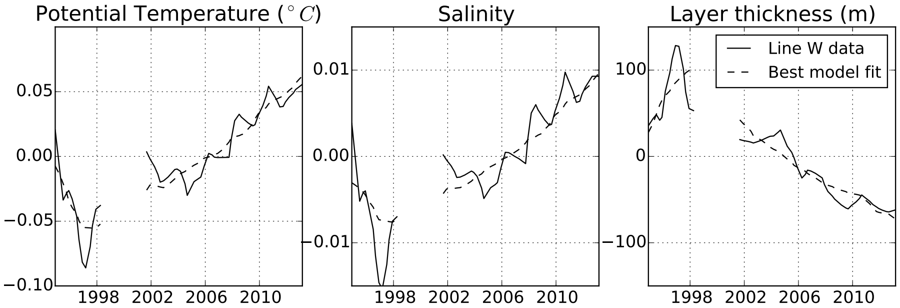
Analytical solution for periodic signal



- Fit sinusoids: oscillation period, phase lag and relative amplitude
- Use analytical expression to find t_{adv} and t_{mix}

$\rightarrow t_{adv} = 4 - 6$ years
$\rightarrow t_{mix} = 2 - 5$ years

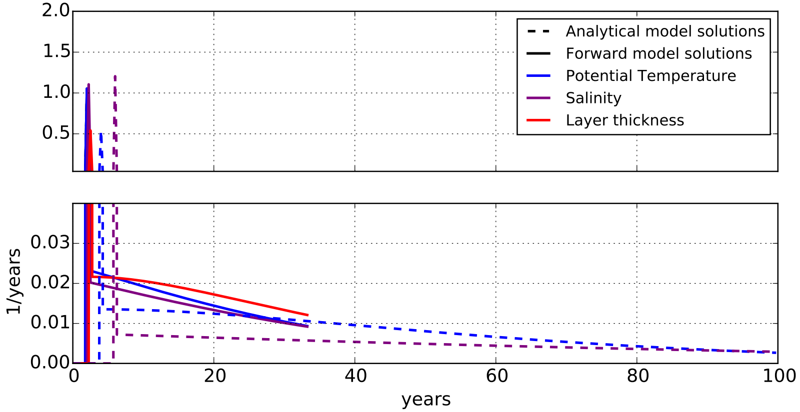
Forward model fit



- Propagate Labrador Sea data forward in time with Green's function
- Minimize cost function to find t_{adv} and t_{mix}

$\rightarrow t_{adv} = 2 - 2.5$ years
$\rightarrow t_{mix} = 1.25 - 1.75$ years

dLSW Transit Time Distributions



Good agreement with Smith et al. 2016

Corresponds to $u \approx 2 - 5\ cm/s$, agrees with DWBC measurements

Estimating diffusivity

$$\kappa = \frac{L \times D}{t_{mix}} = \frac{100\ km \times 4500\ km}{2.5\ years} \approx 6000\ m^2/s$$

L: DWBC width
D: Distance between Labrador Sea and Line W

Elevated compared to estimate of $\kappa = 1000\ m^2/s$ in eastern North Atlantic from tracer release experiment (Ledwell et al. 1998)

Conclusions

- Trace a shift in dLSW salinity, temperature and thickness along the western boundary
- Estimate travel time distribution
- Consistent with tracer studies and DWBC velocities
- First order role for both advection and stirring

"Tracking Labrador Sea Water property signals along the DWBC"
Le Bras, Yashayaev, Toole; under review in JGR: Oceans

Posters

- *Toole, Andres, Le Bras, Joyce, McCartney, Smethie* “Moored Observations of the Deep Western Boundary Current in the NW Atlantic: 2004-2014”
- *Le Bras, Jayne and Toole* “Interaction between the Gulf Stream Northern Recirculation Gyre and the Deep Western Boundary Current – A model study”