Partial decoupling of volume and salt transport in the Florida Current

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Data from Western Boundary Time Series Project
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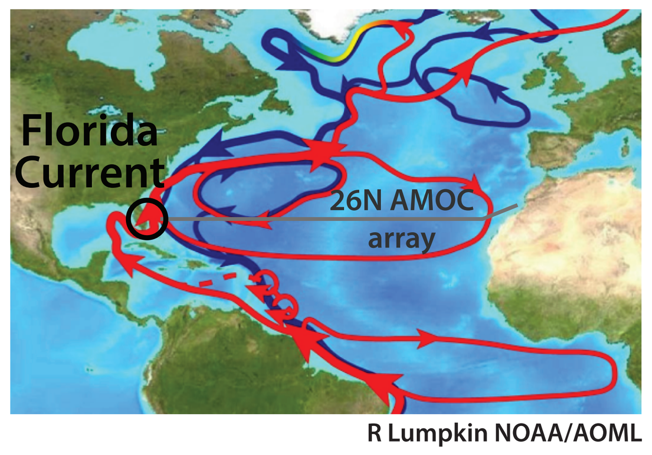
1. Motivation

What sets fluxes of salt (or freshwater) in the subtropical North Atlantic?

Previous studies of the Florida Current (Schmitz and Richardson,1991) identified fresher water masses from the southern hemisphere as carrying AMOC, consistent with volumetric pathways. Do decades of sampling the Florida Current support this?



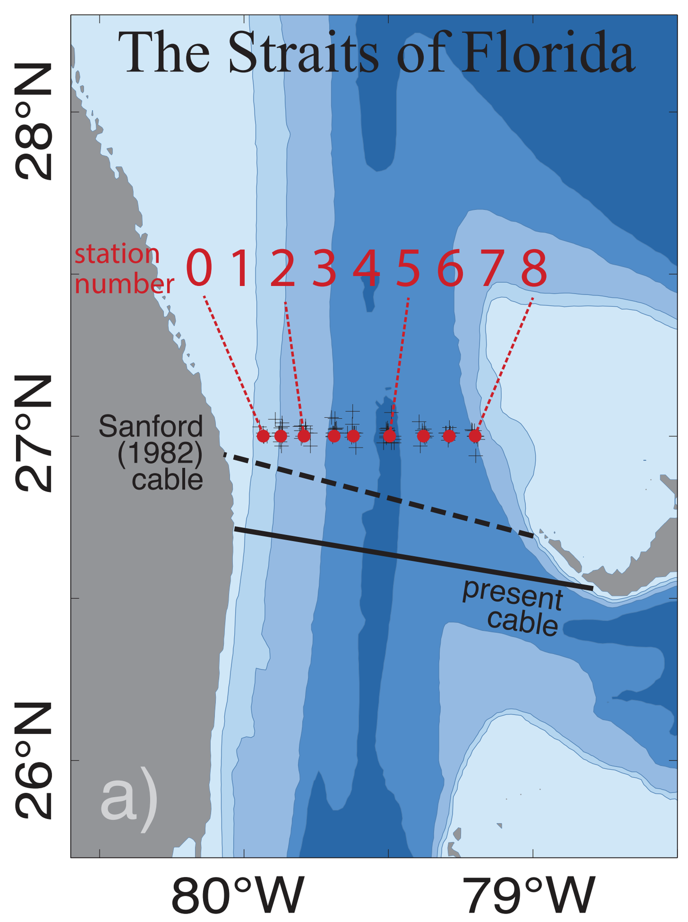
2. Data

The Florida Current, the largest northward current across 26N, has been monitored at 9 repeat stations.

1982-1986 Transects with CTDs (N=9-11) and Pegasus velocity (N=65)

2000-2014 CTD/ LADCP transects by NOAA/AOML (N=51)

Analysis Sections are averaged on isopycnals for T, S, V.



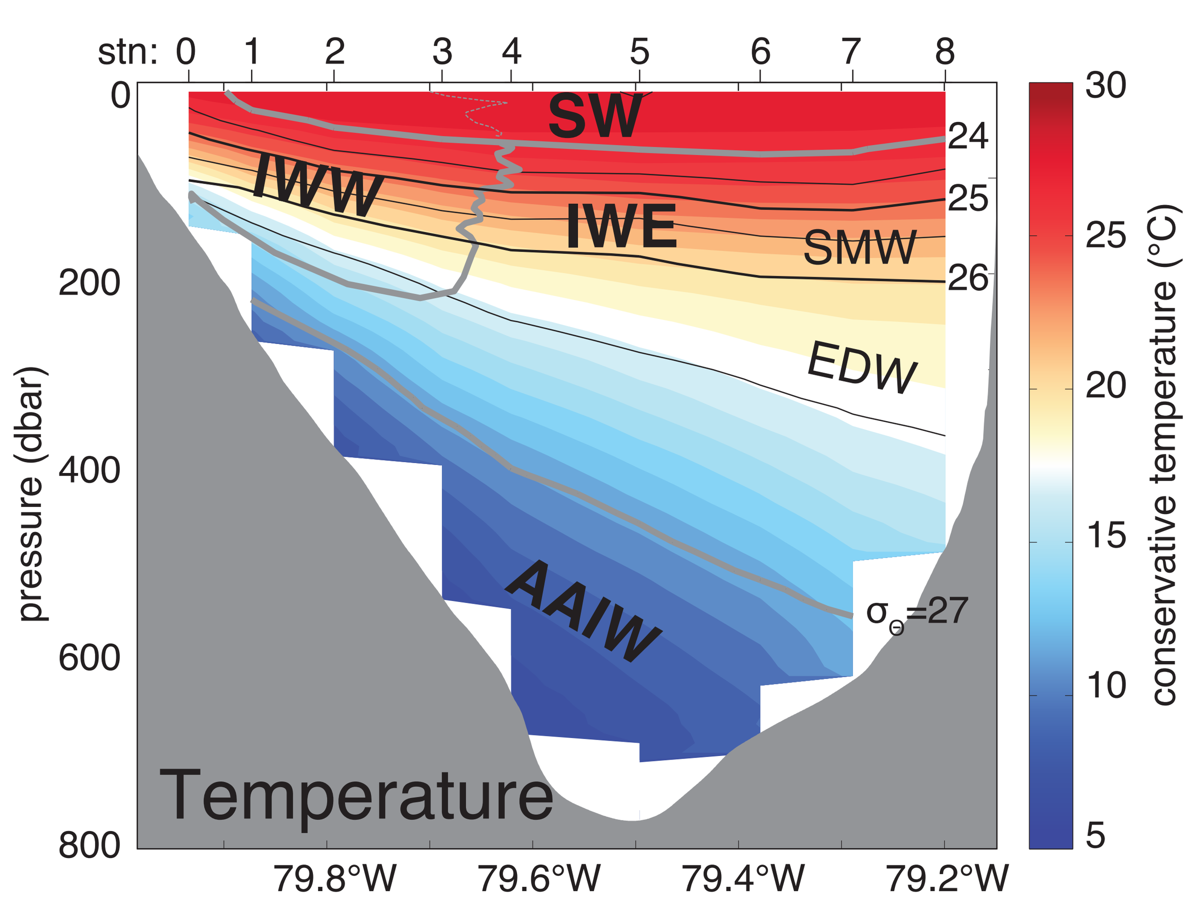
Salinity anomaly transport is calculated as:

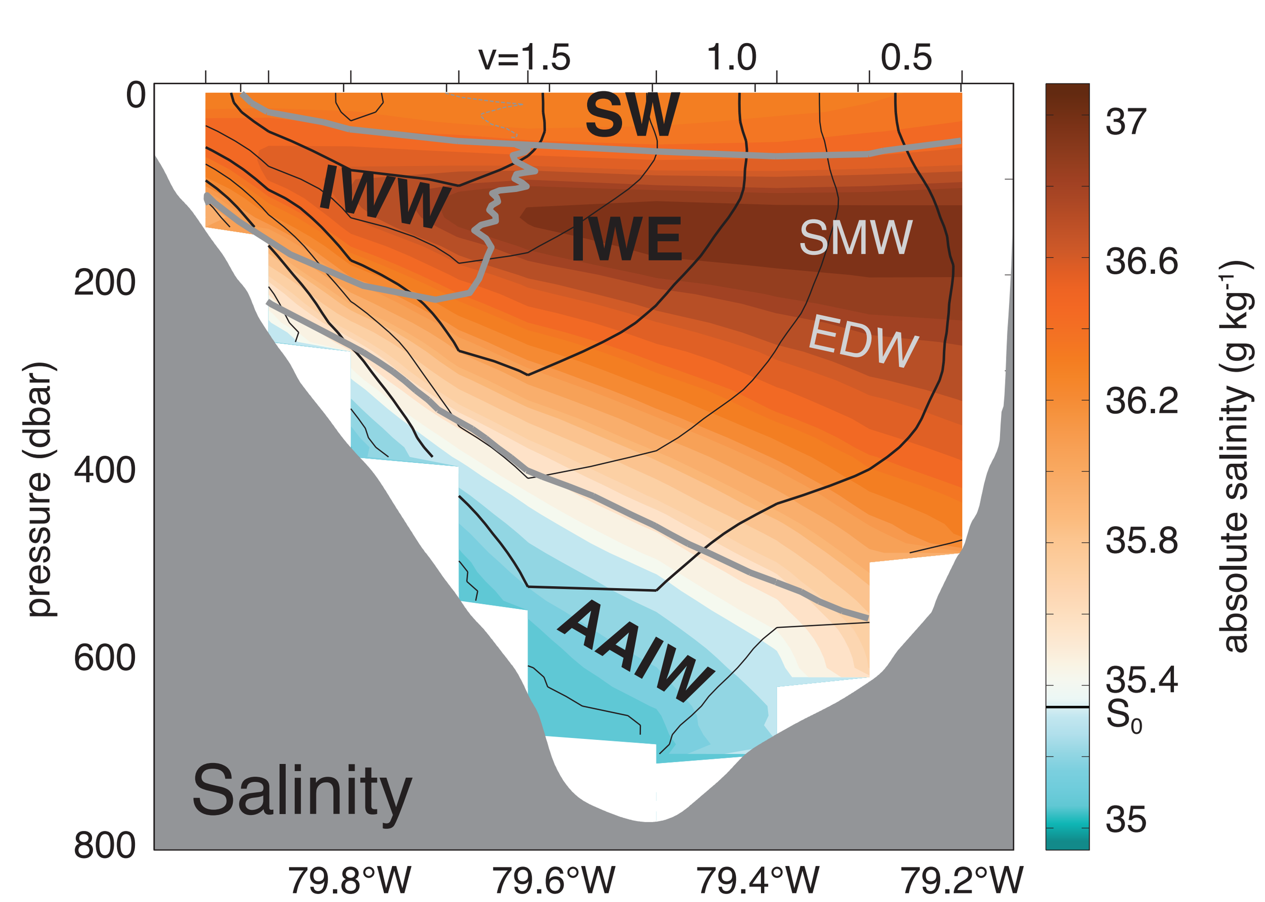
$$T_{sal} = \iint v(S - S_0)\, dx\, dz$$

where S_0 is the area-averaged constant across 26N (S_0=35.338 g kg^{-1}, McDonagh et al., 2015). Confidence intervals are from Welch's T-test at 95% confidence.

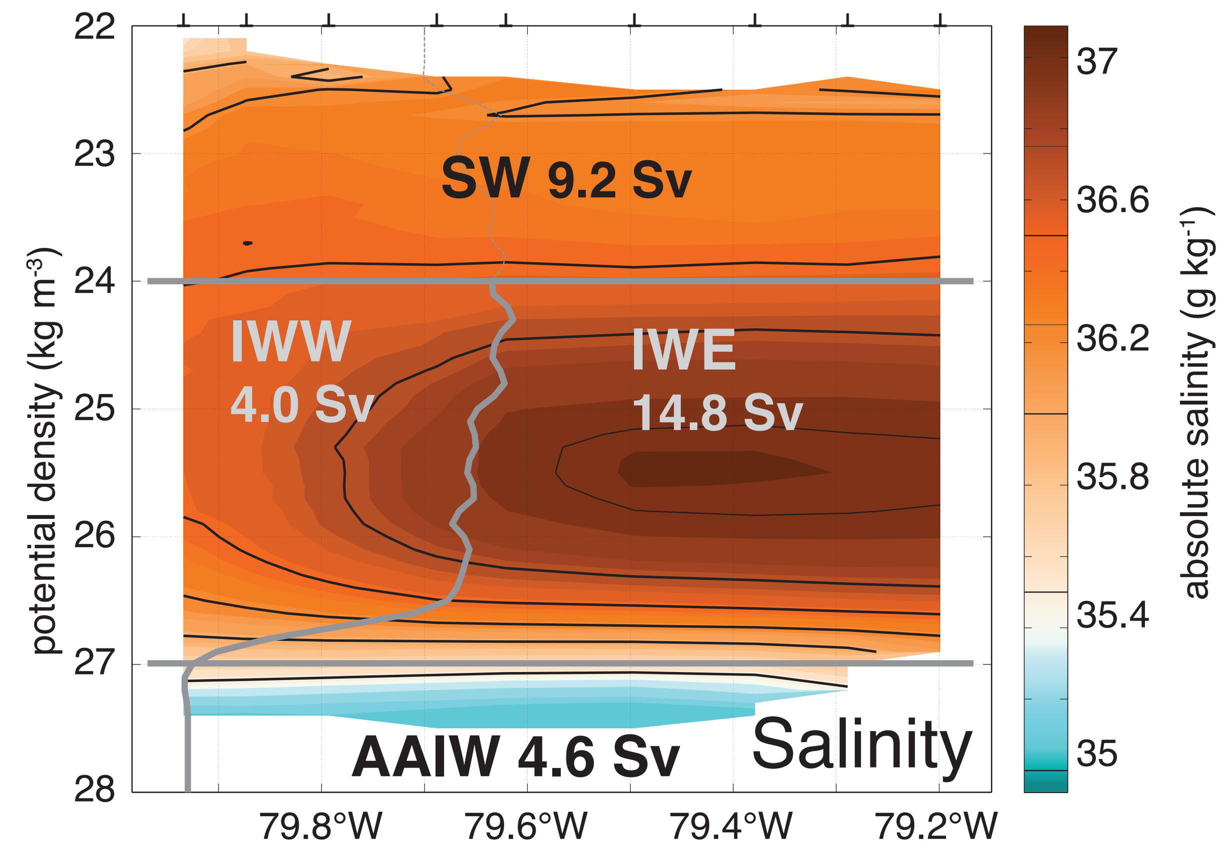
3. Water Mass Structure

Average sections from 2000-2014 (below), show 4 water classes: surface water (**SW**, $\sigma < 24$), Antarctic Intermediate Water (**AAIW**, $\sigma > 27$), and Intermediate water (IW, $24 < \sigma < 27$) divided into east (**IWE**) and west (**IWW**). A front of Ertel's potential vorticity separates IWE, which contains two North Atlantic water masses (Salinity Maximum Water, SMW, and Eighteen Degree Water, EDW), from IWW, which has an ambiguous origin. AAIW is the from the Southern Hemisphere.





4. Mean volume transport: which water masses contribute to AMOC?



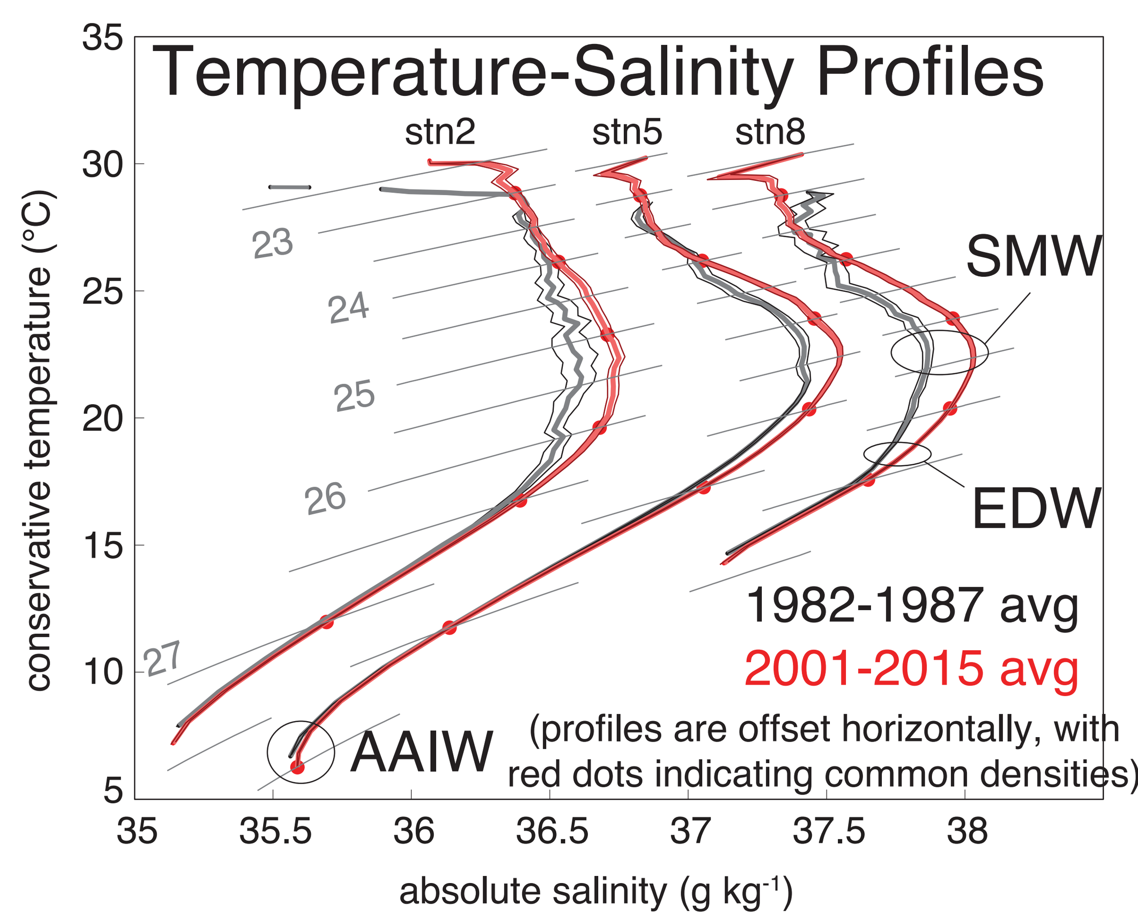
The Florida Current carries the upper AMOC branch (17 Sv) plus most of the wind-driven gyre (Johns et al., 2002). Which water masses are most likely to leave the subtropics along AMOC pathways?

SW: not likely, as surface layer water stays in the subtropics (Foukal and Lozier, 2016)
IWW: highly likely, because it is west of the PV front
AAIW: possible, because unconstrained by PV
IWE: least likely, east of PV front

The probable sources are insufficient (IWW+AAIW = 8.6 Sv), requiring some contribution from IWE or SW.

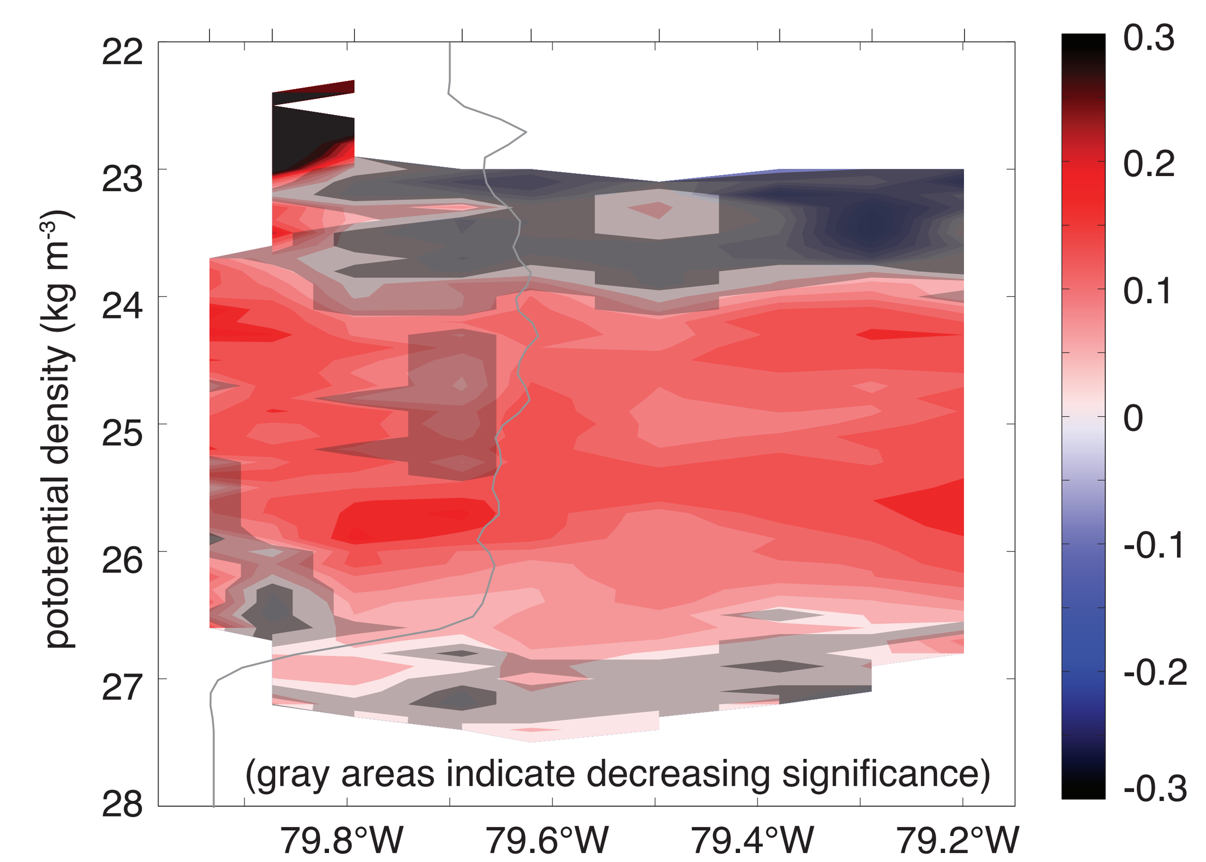
Thus, water classes with North Atlantic signatures appear necessary to constitute AMOC transport in the Florida Current.

5. Decadal salinity changes: what processes influence water properties?



(left) Well-defined water masses have become saltier. Subtropical North Atlantic water masses (SMW and EDW) reflect increased evaporation, while saltier AAIW is in contrast to a freshening trend at its source (Durack and Wijfels, 2010).

(right) All subsurface water has salinified on isopycnals, with the most distinct changes in IWE. This increased total salinity anomaly transport by 3%.



6. Conclusions

- Waters with subtropical North Atlantic signatures contribute substantially to the AMOC fraction carried by the Florida Current.
- Decadal salinification of all subsurface waters is explained easiest by diffusive transport of salt from increased subtropical evaporation, even for fresh water from the southern hemisphere.

Our results suggest that, in the subtropics, local mixing significantly modifies water flowing along overturning pathways. As a result, advective fluxes associated with overturning are influenced by subtropical air-sea exchange, and volumetric and advetive pathways are partially decoupled.

Results from:

Z. B. Szuts and C. S. Meinen. Florida current salinity and salinity transport: mean and decadal changes. Geophys. Res. Lett., 44:10495–10503, 2017.