Salinity and Water Mass Transports in the Florida Straits

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1. Introduction

Motivation Salinity or freshwater transport in the Atlantic pre-conditions deep water formation, and its direction is related to the stability of the overturning circulation (*Drijfhout et al.*, 2010). As part of calculating the basin-wide freshwater transport at 26°N from the RAPID/MOCHA array (McDonagh *et al.*, in prep), complementing time-series of volume and heat flux (*Cunningham et al.*, 2007; *Johns et al.*, 2011), here perform the first analysis of salinity transport in the Florida Straits. The relation of Florida Straits transport to global overturning circulation is shown by the amount of waters originating from the North or South Atlantic.

Approach

1. characterize seasonal and spatial variability of salinity, velocity, and temperature
2. calibrate the submarine cable for salinity transport
3. perform a T/S analysis to estimate transport for waters of North or South Atlantic origin.

2. Data

Data Since 2001, NOAA/AOML has collected the first set of calibration transects with salinity using a CTD/LADCP system. We analyze 31 transects at 9 stations (Fig. 1), in addition to submarine cable measurements (*Meinen et al.*, 2010).

After de-tiding and gridding the data, we calculate areal integrals of volume, temperature, and salinity transport for each transect. Salinity transport is relative to a basin-averaged value of $S_{\text{ref}} = 35.156$ psu. Volume and heat transport calibrations (not shown) are consistent with other datasets (*Shoosmith et al.*, 2005).

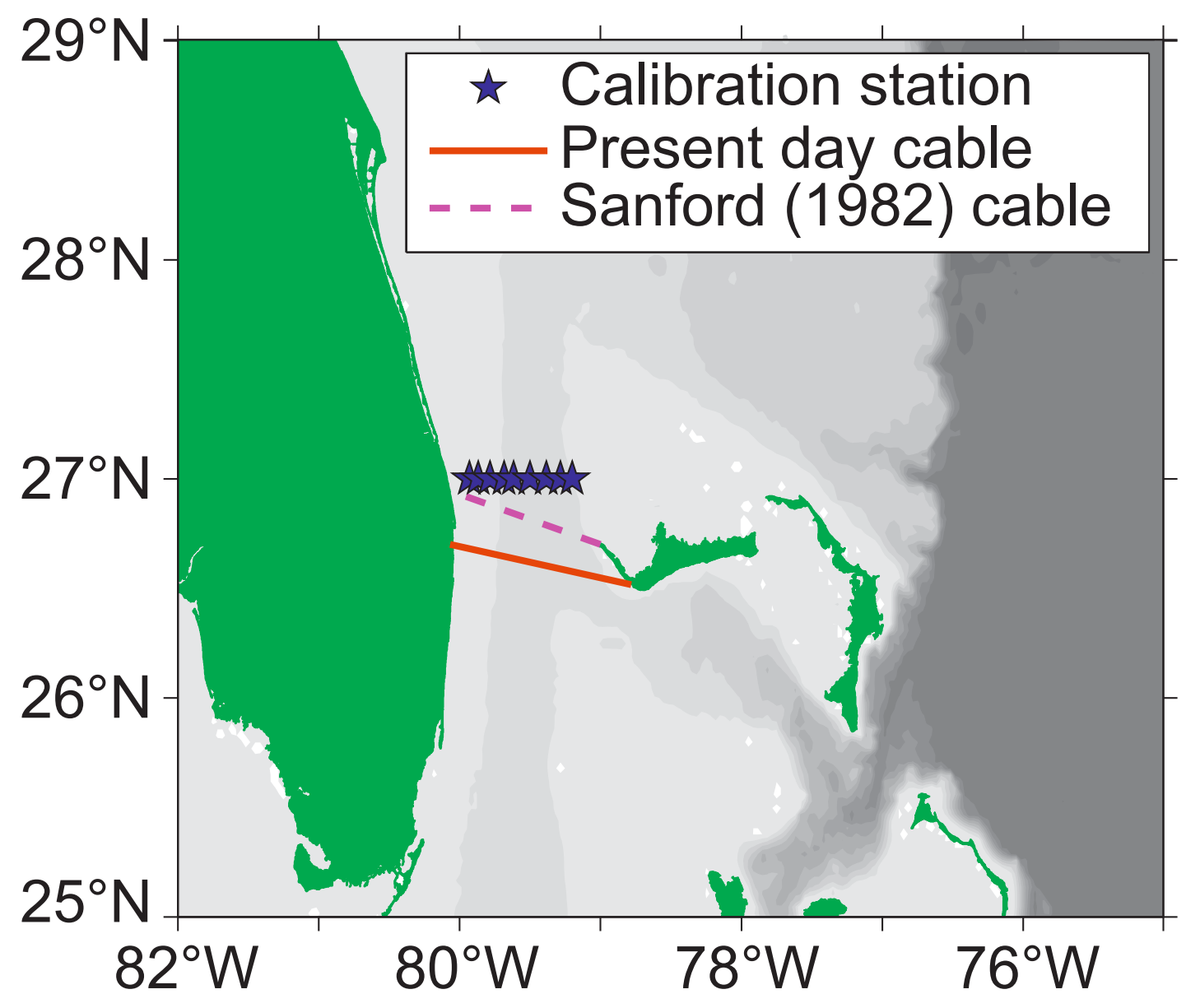


Figure 1. Map of the Florida Straits (from *Meinen et al.*, 2010).

3. Seasonal and spatial patterns

With few transects and variance at all frequencies (*Meinen et al.*, 2010), a **seasonal cycles** can only be found for temperature but not for velocity or salinity.

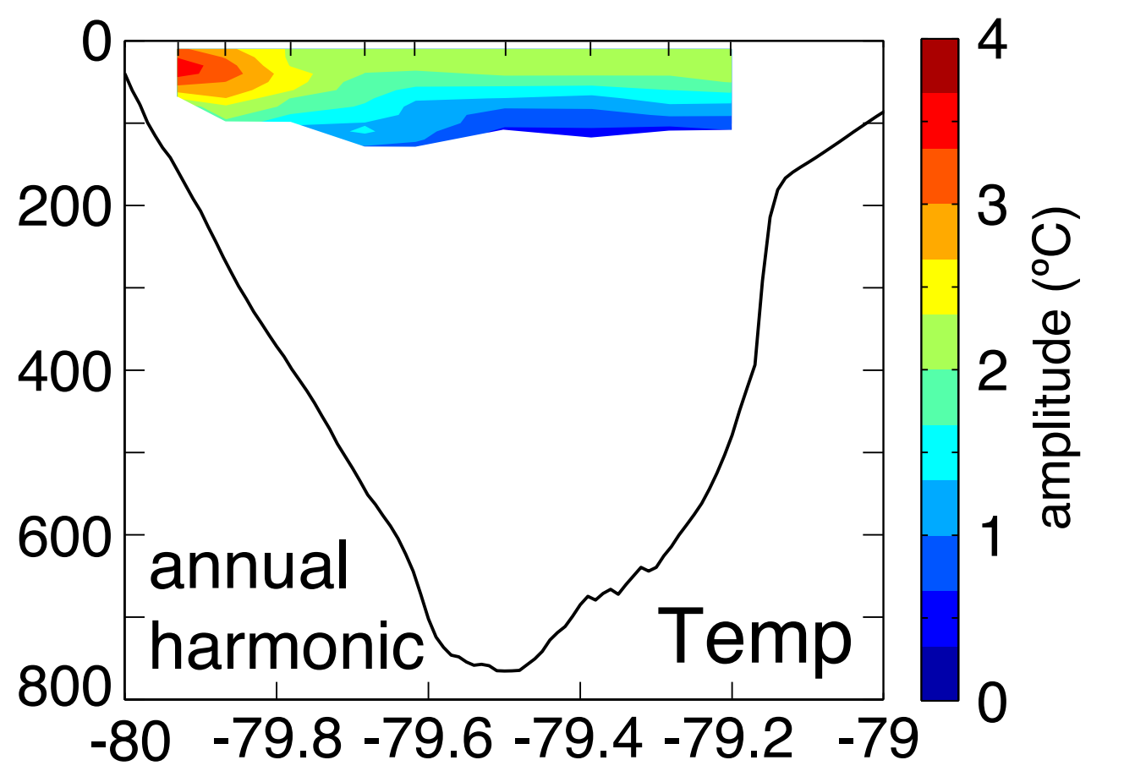


Figure 2. The annual harmonic for temperature, which is strong in the upper 100 m, is maximum in Jun–Jul, and explains 50–90% of the variance at these depths.

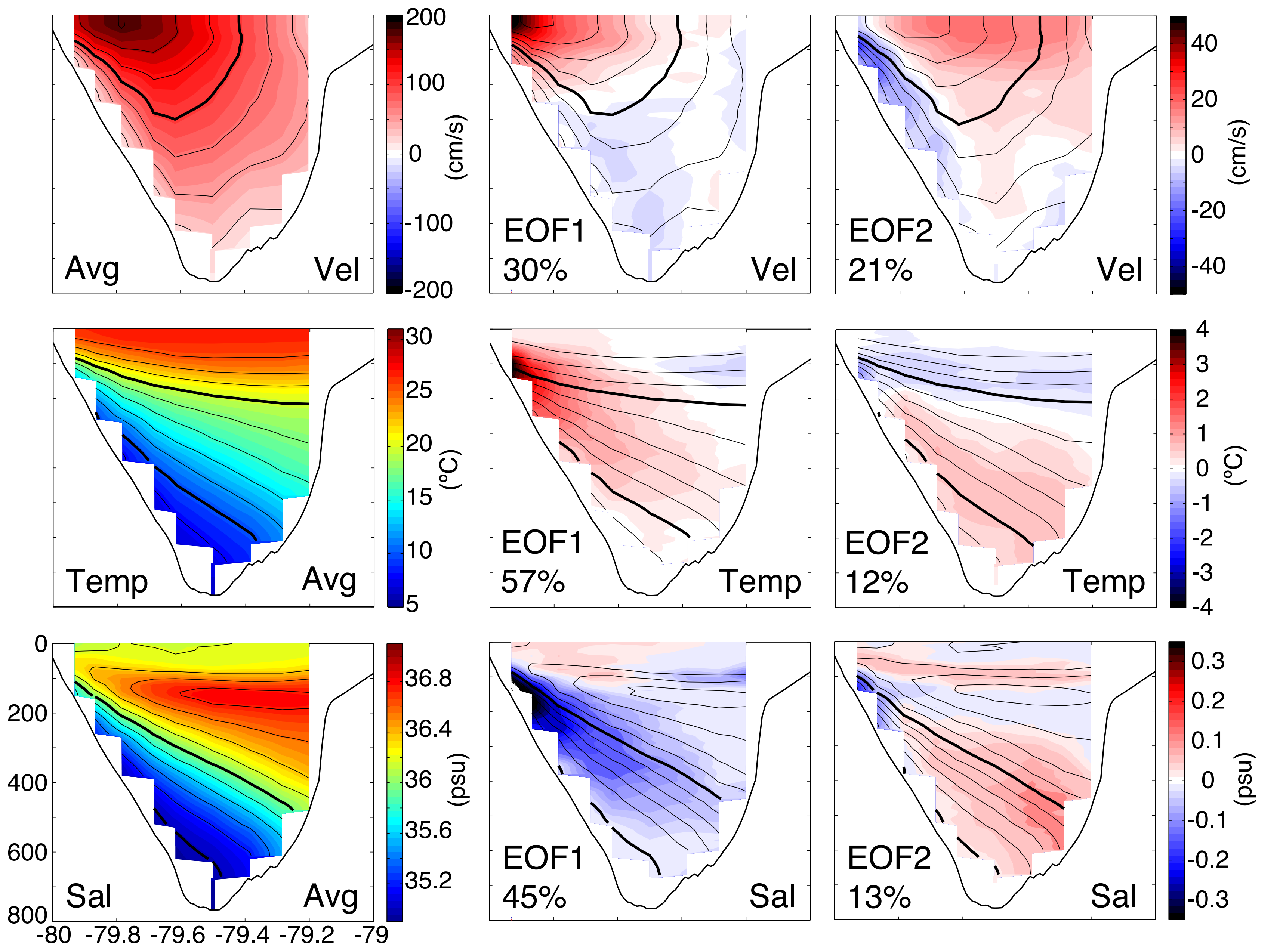


Figure 3. Spatial averages and EOFs of velocity, temperature (seasonal cycle removed), and salinity. Variance explained is shown for the EOFs, and the second EOFs of temperature and salinity are only marginally statistically significant.

Spatial patterns show that fast velocities and strong fluctuations near the surface correspond to average fields of warm temperatures and mid-range salinities. In contrast to the seasonal temperature cycle, EOFs of temperature and salinity do not overlap on the average or EOFs of velocity.

4. Salinity calibration

To estimate salinity transport from continuous cable measurements, we regress salinity transport against volume transport.

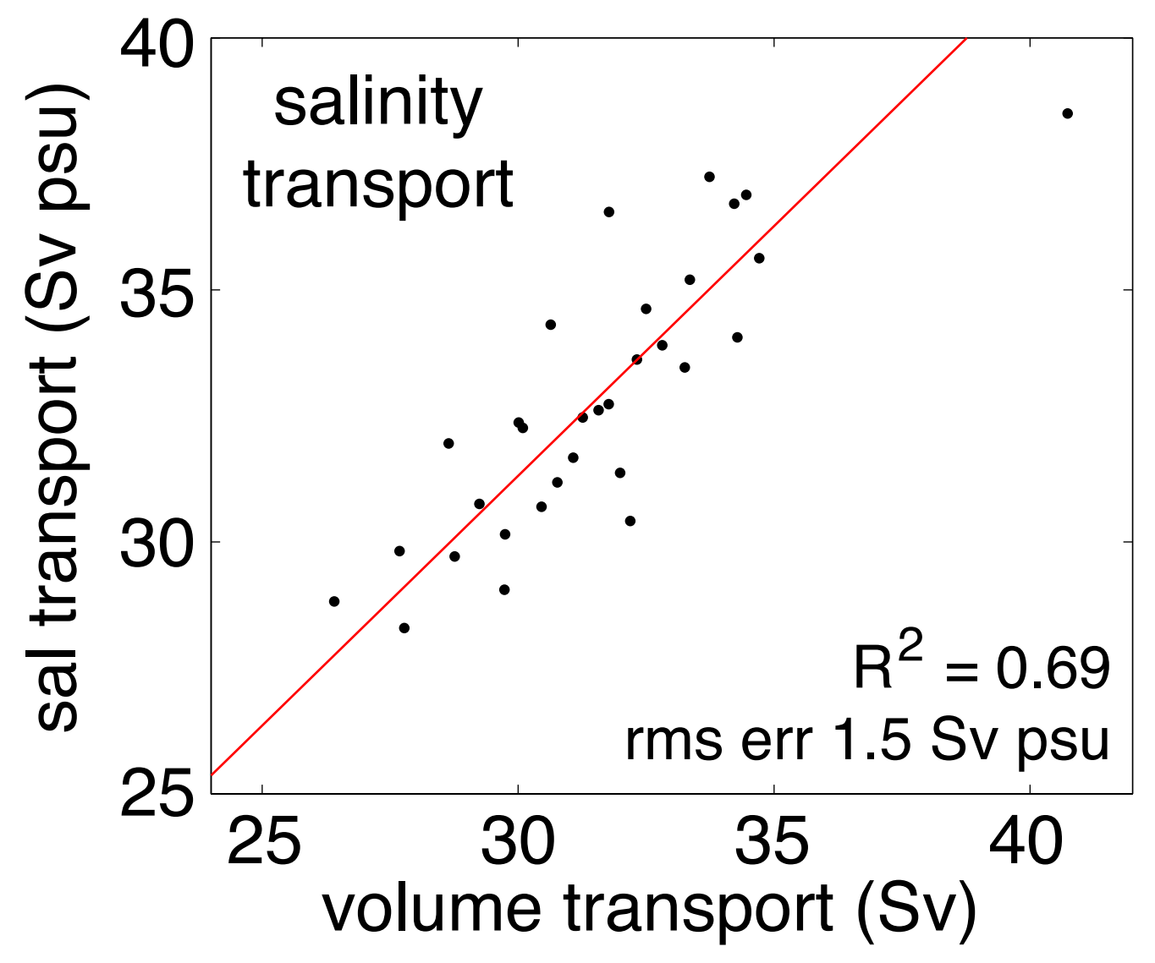


Figure 4. The fit is accurate to an rms error of 1.5 Sv psu and has $R^2 = 0.69$. This is less accurate than for temperature transport, which we attribute to a lack of seasonal cycle in salinity and a mismatch between regions of maximum salinity and regions of strong velocity.

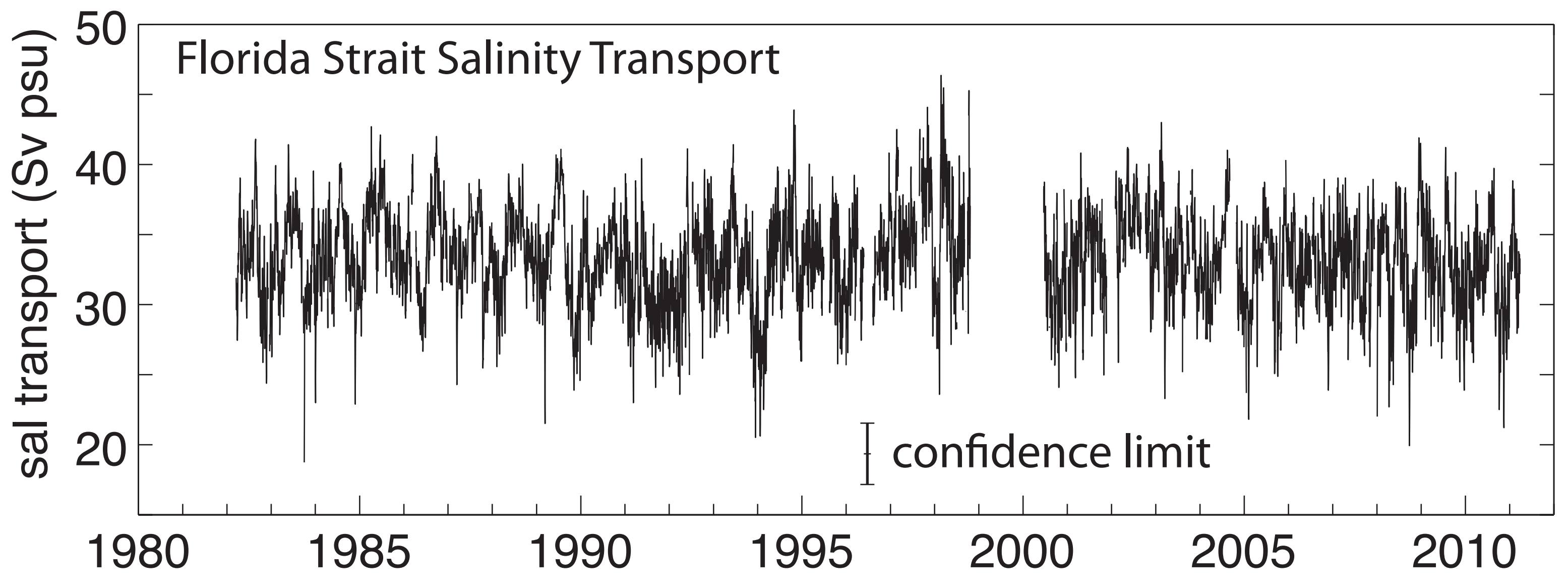
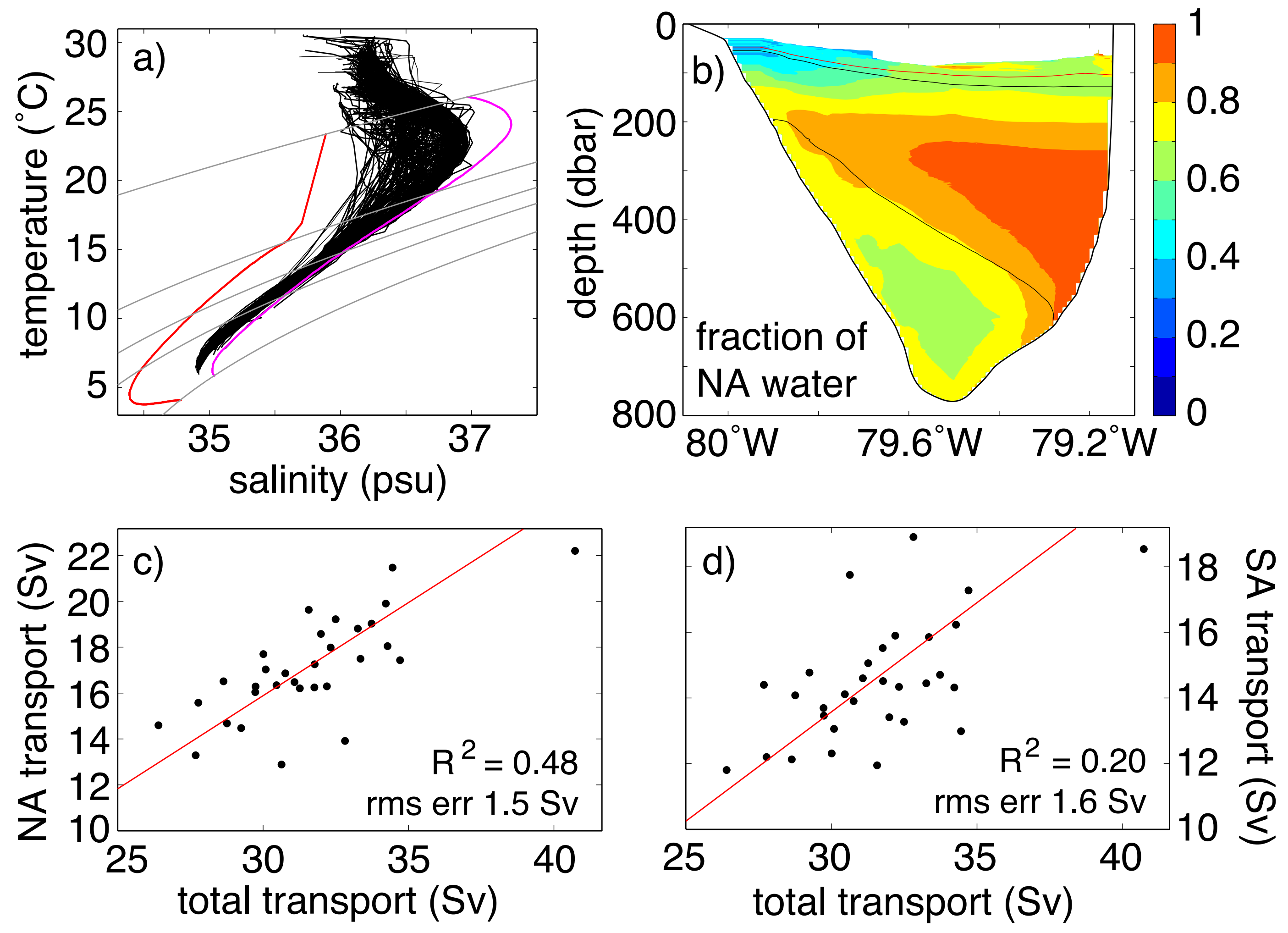


Figure 5. Applying the salinity calibration to the cable transport yields a time-series with an average ± standard deviation of 33.3 ± 3.3 Sv psu. Accounting for uncertainties in the cable-derived volume transport, we expect that the cable-derived salinity transport recovers 40% of the variance and is accurate to 2.2 Sv psu. This error is 5-times smaller than the 90-percentile range of 27.7–38.6 Sv psu derived from the cable.

5. Volume transport by origin classes

Figure 6. To determine **water origin**, we implement the isopycnal water mass mixing analysis of *Rhein et al.* (2005) with source T/S profiles for South Atlantic (red) and North Atlantic (magenta) waters (Fig 6a). Salty mid-depth waters on the east side mostly originate from the North Atlantic (Fig 6b) and contribute 17 Sv of transport. South Atlantic waters colder than 12°C or warmer than 24°C (black lines, Fig 6b) contribute 14 Sv.



Regressions of origin-class transport against total volume transport is weakly significant for waters of North Atlantic origin (Fig 6c–d), implying a stronger link between Florida Straits transport and pathways from the North Atlantic. Neither origin-class is strongly correlated with temperature or salinity transport (not shown).

6. Conclusions

- Salinity transport derived from the submarine cable gives an average ± standard deviation of 33 ± 3 Sv psu, which is accurate to 2 Sv psu.
- Salinity transport is less accurate to predict from the cable than temperature transport because of limited overlap between spatial patterns of velocity and salinity
- Water of North Atlantic origin accounts for 17 Sv of volume transport, while that of South Atlantic origin accounts for 14 Sv.
- Transport of North Atlantic water is correlated with total transport, suggesting that fluctuations in Florida Strait transport reflect changes in gyre recirculation.

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