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# A comparison of transport and position between the Gulf Stream east of Cape Hatteras and the Florida Current

Alejandra Sanchez-Franks[1], Charles Flagg[1], Thomas Rossby[2]

[1]Stony Brook University [2]University of Rhode Island

## ABSTRACT


- The Florida Current (FC) transport and Gulf Stream (GS) transport and position have been measured almost continuously for many decades
- Both currents have been linked to the North Atlantic Oscillation (NAO); in particular, measures of the GS position show a high statistical relationship with atmospheric forcing
- Here we show five different proxies for the position of the GS' path and find all five measures are internally consistent; local measurements also prove to be good representatives of overall zonal shifting (from 65°W to 79°W)
- The second part of the study shows that the statistical relationship between the GS position proxies and transports is inversely correlated with r values of ~-0.30, significant at 85% level.
- GS transport and FC transport are not statistically significantly correlated to each other.
- Though both position and transports for the GS and FC are shown to be linked to the NAO, the lack of a more robust statistically significant relationship between GS and the FC transport indicates that the GS does not have detectable signal in the Florida Straits (the NAO must influence them via different intermediate processes or pathways).


## DATA & METHODS

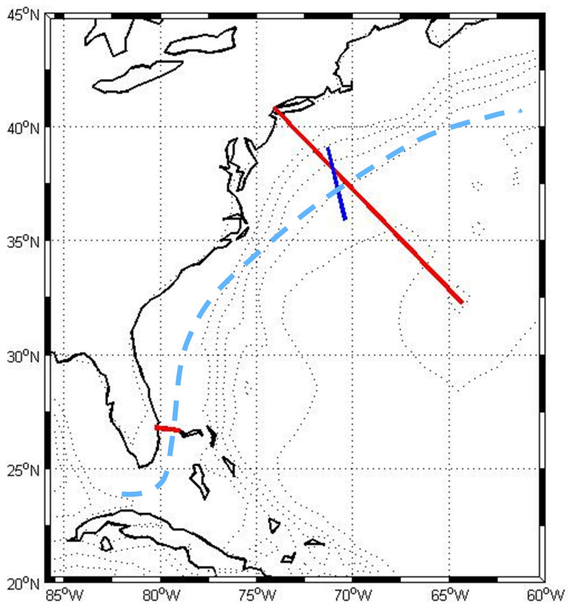


**Figure 1, Map of our area of interest with the approximate location of the GS (dashed blue line). The top red line indicates the Oleander trackline, traveling from New Jersey to Bermuda. The small lower red line is where the Western Boundary Time Series records FC data at ~ 27 N. Blue line shows the section from the satellite pass. The dotted lines indicate depth ranging from 0 to 5000 m.**

## GULF STREAM POSITION INDICES

- The 15°C isotherm at 200 m
- The Stream's position via the Northwall (indicated by the 2°C drop in surface temperature northward from the location of maximum velocity),
- The position of the velocity maximum at 55 m (from the Oleander transects),
- The SST anomaly along 71°W from satellite imagery,
- The location of the maximum along-track gradient in SLA, and
- The zonally averaged SST gradients, from Taylor and Stephens (1998).

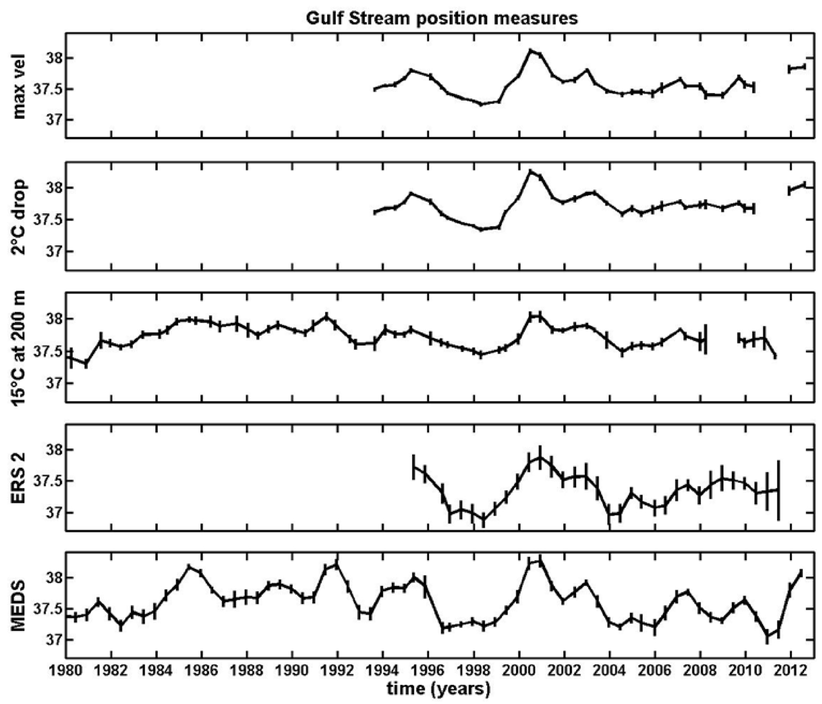


**Figure 2, Five indices of GS position from the Oleander's ADCP and XBT, i.e. position of max velocity, location of 2°C drop and 15°C isotherm at 200 meters, and from satellite data, i.e. ERS 2 and MEDS.**

## GULF STREAM & FLORIDA CURRENT TRANSPORT

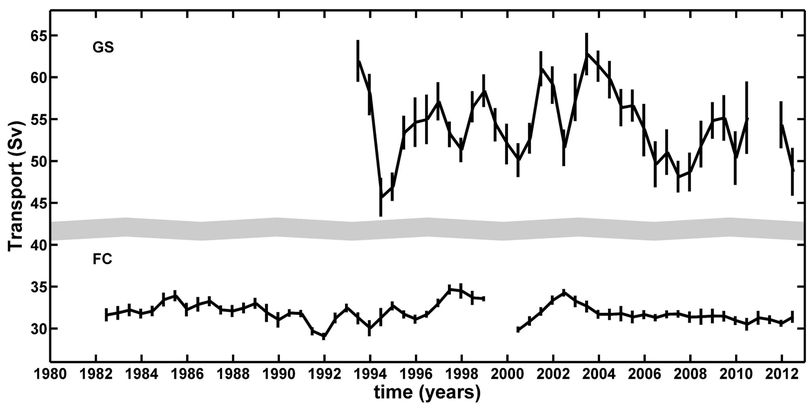


**Figure 3, GS and FC transport (Sv) annually averaged and stepped every 6 months. A break in the y axis is introduced to eliminate blank space between 40 and 80 Sv.**

| | 15°C at 200 m | Max Vel | 2°C drop | MEDS | ERS 2 | Taylor Index | GS trans | FC trans |
|---|---|---|---|---|---|---|---|---|
| 15°C at 200 m | 1 | 0.67 | 0.69 | 0.75 | 0.81 | 0.64 | - | - |
| Max Vel | | 1 | 0.94 | 0.90 | 0.85 | 0.70 | -0.25 | **-0.44** |
| 2°C drop | | | 1 | 0.83 | 0.82 | 0.59 | - | **-0.48** |
| MEDS | | | | 1 | 0.81 | 0.67 | -0.34 | -0.21 |
| ERS 2 | | | | | 1 | 0.79 | - | - |
| Taylor index | | | | | | 1 | -0.30 | -0.25 |
| GS trans | | | | | | | 1 | - |
| FC trans | | | | | | | | 1 |

**Table 1, Cross-correlations between all GS position and transport time series and the FC transport. Values that are statistically significant at 99% level are in bold. The rest are significant at 85% level, at least.**

## DISCUSSION

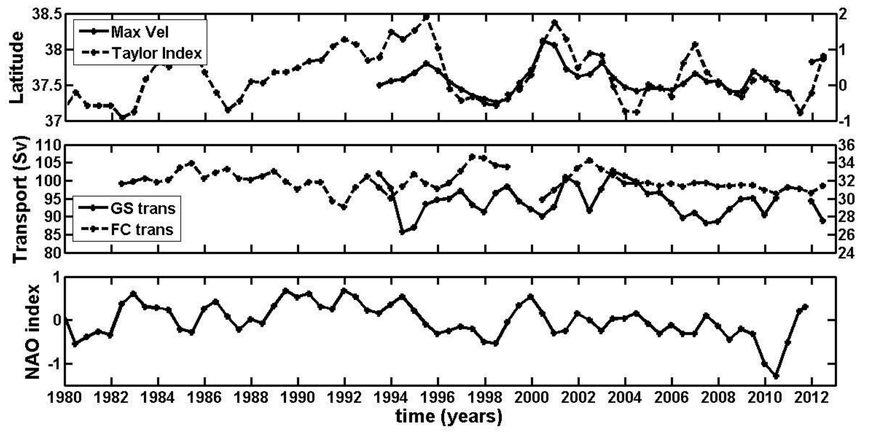


**Figure 4, Top panel shows position of maximum velocity (solid line) corresponding to the left y-axis (latitude) and the Taylor Index (dashed line) associated with the right y-axis (no units). Both GS (solid line) and FC (dashed line) transport can be seen in the middle panel; left (right) axis corresponds to the GS (FC) transport and units are in Sverdrup. The NAO index is indicated in the bottom panel. All time-series are annually averaged and 6 month stepped.**

| Variable | n | Lag (years) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 |
| Max Vel | 37 | -0.39 | - | - | 0.37 | 0.34 | - | - |
| MEDS | 92 | 0.20 | **0.34** | **0.43** | **0.40** | **0.32** | **0.31** | **0.28** |
| Taylor | 92 | - | 0.26 | **0.45** | **0.44** | **0.39** | **0.35** | **0.29** |
| GS Trans | 37 | - | -0.36 | -0.37 | - | - | - | - |
| FC Trans | 60 | - | - | - | - | - | 0.19 | 0.21 |

**Table 2, The sample size n, and cross-correlations between position measures and transports with the NAO as the leading variable. Values that are statistically significant at 99% level are in bold. The rest are significant at 85% level, at least.**

## CONCLUDING REMARKS

- When comparing correlation coefficients between the position proxies, the highest r values correspond to the location tracked from the maximum velocity vector, 2°C drop, MEDS, and ERS 2. This indicates internal consistency.
- The high correlation associated with the Taylor index shows that local measurements of the Gulf Stream position are good representatives of the overall zonal shifting, on year-long times scales.
- The NAO index shows agreement with the position proxies and an inverse correlation with both transport. During high NAO the Gulf Stream position is shifting north, and the Gulf Stream and Florida Current are decreasing in volume transport, taking corresponding lags into account
- Position proxies are as correlated with the Florida Current transport as they are with the Gulf Stream transport, though no one position index has a statistically significant correlation coefficient with both transports (i.e. if one position proxy has a statistical significant relationship with one transport time series, it won't with the other)
- The Gulf Stream transport time series appears to have the highest correlation coefficient with MEDS and Taylor index, significant at 85% and 90% levels, respectively. The fact that the Florida Current transport exhibits its highest correlation with the 2°C drop, higher than with the Taylor index, indicates that caution in taking these numbers too literally.
- Last, we find no statistically significant relationship between the Florida Current transport and the Gulf Stream transport.
- We believe these results suggest both currents are affected by the NAO to different degrees and by different intermediate processes.

## ACKNOWLEDGEMENTS

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