

# Characterizing spring and summer Gulf Stream water intrusions in the mid-shelf of the South Atlantic Bight

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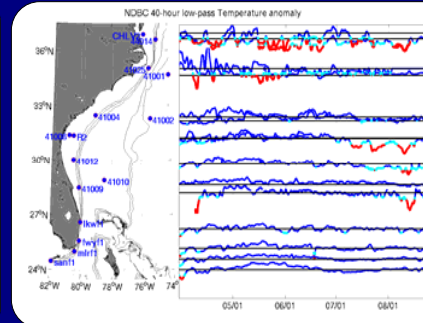
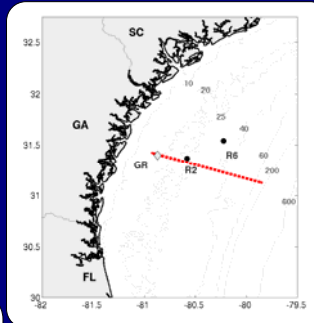
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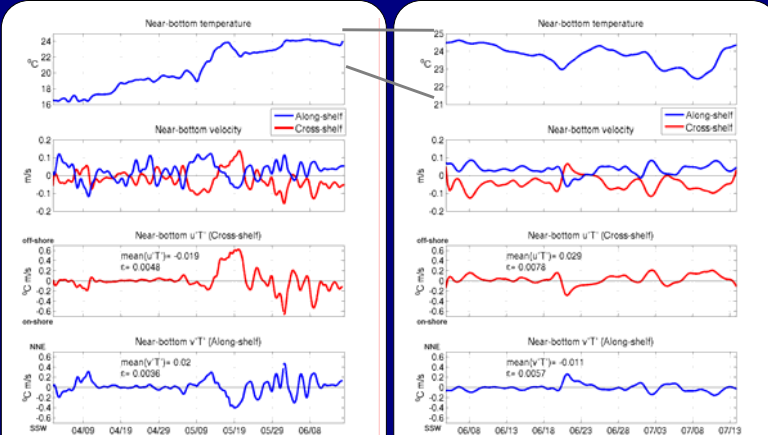
## Abstract:

Intrusions of Gulf Stream waters on the South Atlantic Bight (SAB) outer-shelf associated with the meandering of the Stream are common during all seasons. Detection of these intrusions in the mid-shelf is rare. However, in the spring of 2003, several of these intrusions were detected as far inshore as the mid-shelf at the SABSOON towers off Georgia and South Carolina (in depths less than 40m). During that time, hydrographic surveys in the central SAB showed a transition from a vertically mixed water column with strong cross-shelf salinity gradient, to a strongly vertically stratified water column. The transition was enhanced by the passage of the Gulf Stream intrusions and constituted the onset of a much larger event that resulted in anomalously cold water over much of the subsurface waters in the SAB shelf affecting even the near-shore areas. During late spring and early summer the mechanism for advective heat flux on the mid-shelf was associated with pulses of poleward along-shelf flow and onshore cross-shelf flow. This was consistent with intrusions of cold water in the southern SAB shelf and its propagation along-shelf into the central SAB region on time scales of 10-15 days. The cross-shelf heat flux was driven by pulses with a 3-5 day period, which was consistent with the passage of Gulf Stream frontal eddies along the shelf-break and atmospheric systems passage.



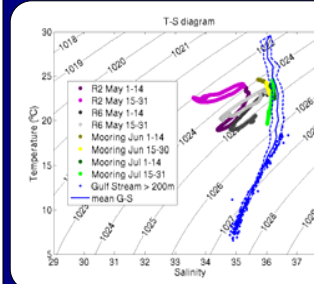
The intrusions observed in the mid-shelf were part of a major event that extended from Florida to New Jersey (Sun et al, 2004; Schwing and Pickett, 2004; Aretxabaleta et al, 2005). The main signal was the presence of cold water over most of the shelf. The anomalously cold water was observed at the surface during the late part of the summer, but the event started in early June. The main signal in the central SAB was an anomaly of 6-8 °C in the bottom temperature.

The event was controlled by the anomalously strong and persistent winds, the presence of strong salinity stratification during spring and the dynamics of the Gulf Stream and its instabilities



The reduced advective heat flux during April increased significantly during May by the action of pulses in both the along- and cross-shelf directions with periods of 2-5 days. The resulting net effect was small by the compensating effect of each component, but the main positive increase occurred in early May.

The advective heat flux during June and July was smaller and controlled by few pulses on time scales of 10-15 days. The main net flux was positive and in the cross-shelf direction associated with flux of cold water on-shore. The along-shelf component also contributed to the cold water intrusion and separating each contribution is complicated.

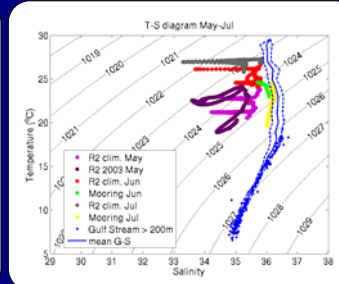


During April and May pulses in river discharge and passage of atmospheric systems controlled the dynamics of the inner- and mid-shelf. The T-S characteristics of the water on the shelf had significant pulses associated with downwelling-favorable wind. A TS distance to the Gulf Stream characteristics was defined as:

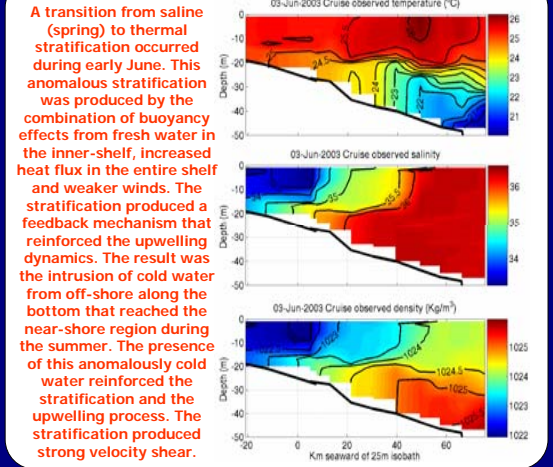
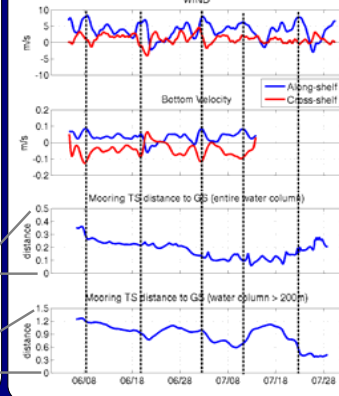
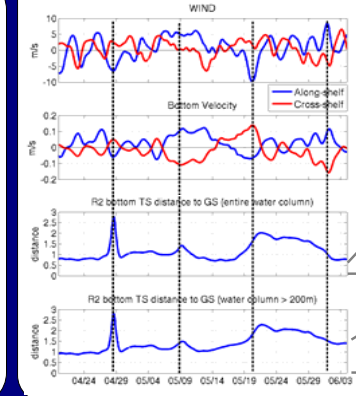
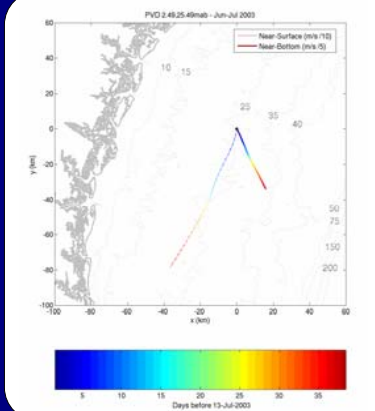
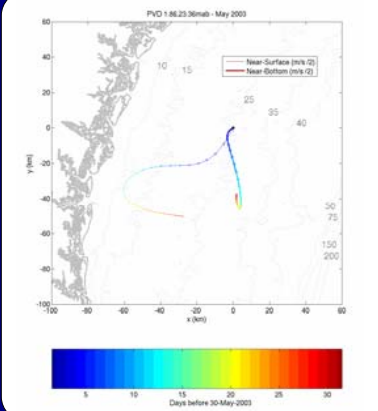
$$(d_{TS})_i = \alpha |S_i - T_{CS}| + \beta |T_i - T_{CS}| * 1000$$

where  $\alpha$  is the thermal expansion,  $\beta$  is the saline contraction and  $T_{CS}$  is the temperature of Gulf Stream and  $T_i$  is the observed temperature

This TS distance increased during these pulses (period 10 days) by the advection of fresher water from the inner-shelf.



During June and July the wind was upwelling-favorable (stronger pulses with 10-day period). The bottom velocity was dominated by onshore flow, but significant along-shelf flow remained. The TS distance increased during strong upwelling pulses when evaluated against the entire Gulf Stream water column. The distance decreased when only the deeper part (>200m) of the G-S water column was considered. The general trend during the summer was an increased of the proximity to deep G-S water due to the persistency of the upwelling process.



- ### Conclusions
- Pulses in river discharge controlled the TS characteristics during spring and initiated strong stratification conditions.
  - Strong pulses (2-5-day period) controlled the advective heat flux during spring associated with wind events and (maybe) passage of Gulf Stream frontal eddies.
  - Upwelling-favorable winds dominated the dynamics during summer with strong near-bottom onshore flow.
  - Strong stratification during summer increased upwelling dynamics and separation of surface and bottom processes.
  - Smaller advective heat flux pulses during summer (10-15-day period) intruded cold water onshore from the deeper part (>200m) of the G-S water column.
  - The intrusions were caused by upwelling pulses and along-shelf propagation of previously upwelled water.

### References

- A. Aretxabaleta, J. R. Nelson, J. O. Blanton, H. E. Seim, F. E. Werner, J. M. Bane and R. Weisberg. Cold event in the South Atlantic Bight during summer of 2003: Anomalous hydrographic and atmospheric conditions. In prep.
- Schwing, F. B. and M. H. Pickett (2004). Comment on "Anomalous cold water detected along Mid Atlantic Coast". EOS, 85, 554.
- Sun, D., Z. Liu, L. Chiu, R. Yang, R. P. Singh and M. Kafatos (2004). Anomalous cold water detected along Mid Atlantic Coast. EOS, 85, 152.