The Gulf Stream in the Vicinity of the Rhumb Line Newport to Bermuda June 10, 2014
An Analysis of Conditions

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When viewed on May 12th (see Note #1 – Bermudarace.com) the Gulf Stream crossing the Newport-Bermuda rhumb line was in the process of "recovering" from the effects of a deep meander that had been essentially stationary for more than a month. The meander had pinched off resulting in the formation of a cold core ring, south of the main body of the Stream and a relatively gentle meander immediately west of the rhumb line near 38^0 N $69^0$30' W. It was expected that this meander would migrate slowly to the northeast while the ring drifted to the west.

Contrary to expectations the meander continued to show little movement. By 26 May the composite SST (sea surface temperature) image (Fig.1) showed the meander in the same location as it was on 12 May (see Note #1) while the main axis of the elliptical cold core ring rotated into a more nearly north-south orientation. This rotation brought the counter clockwise rotating ring currents into contact with the main body of the Stream effectively slowing the migration of the meander and facilitating entrainment of the ring. By 2 June this entrainment had served to rapidly reestablish the deep meander by (Fig.2) resulting in the elimination of the ring. This unusual evolution was accompanied by the dispersal of a large mass of warm water extending northwest from the main body of the Stream to the edge of the continental shelf near 40^oN 70^oW. The temperature contrast between this mass and the adjoining waters is sufficient to produce significant currents to the west along 39^o N followed by a northerly component near 71^o W and an east to southeasterly flow along 39^o 30' N (Fig.2) or clockwise similar to the flow expected in a warm core ring. Due to the compositing process used in the production of the satellite image it's difficult to tell if this mass stands clear of direct Gulf Stream effects to form a discrete warm core ring. It appears that it does not but this may change with time.

Cloud cover over the past 10-15 days has made it difficult to obtain daily satellite images complicating evaluation of the evolution of the Stream in the vicinity of the rhumb line. The composite SST image of 8 June (Fig.3) shows a structure similar to that observed on 2 June (Fig.2) with the warm water mass still in place along the shelf margin just west of the rhumb line and a deepening meander. There is slight evidence that the meander is narrowing resulting in a reduction in the separation between the rhumb line and the western limb of the meander. Currents in this limb proceed to the southeast over a distance of more than 120 nm. This combination of clockwise rotating current associated with the warm water mass centered near 39^o N 70^o W and the southeasterly currents in the western limb of the meander in the main body of the Stream favors, at this time, a track to Bermuda west of the rhumb line. Specification of the waypoints for entry and ultimate departure however, requires more detail than is provided by the composite image.

Some additional details of Stream structure can be obtained from selected model products. As I have said in the past I favor particularly the altimetry based model provided by NOAA and available at

http://www.aoml.noaa.gov/phod/dataphod/work/trinanes/INTERFACE/index.html . The website provides coverage of a portion of the equatorial Pacific, the Gulf of Mexico, Caribbean, and much of the Northwest Atlantic. A computer mouse controllable scribe allows selection of small area subsets providing high resolution detailing of a particular area of interest such as the rhumb line region Newport to Bermuda. This is a Java based product which may cause difficulties to some browsers. They can be overcome with persistence. Experience indicates that it's worth the effort.

The model output for 10 June, 2014 (Fig.4) shows that the structure of the Gulf Stream on 8 June (allow 2 days delay for data processing) may be a bit more complicated than suggested by the SST composite image (Fig.3). The warm water mass extending along 40° N in particular appears as two lobes of a limb of the main body of the Stream rather a discrete ring. Near the rhumb line the altimetry shows relatively weak currents with a dominance of latitudinal east-west flow. North-south flows appear in the area west of 70° W or nearly 40 nm west of the rhumb line. Although the model output provides only indication of relative current speeds the small change in elevation in this area indicated by the color coding suggests that maximum currents will be substantially less than those in a fully developed ring or on the order of 1 to 1.5kts.

To the south of the warm water mass, the western limb of the meander in the main body of the Stream is separated from the rhumb line by approximately 60 nm at its northern limit near 38° N 70° W paralleling the rhumb line to approximately 36° 30' N 68° 30 W. Beyond this point the original southeasterly flows become progressively more easterly before the meander crosses the rhumb line near 36° N 67° 30' W or approximately 400 nm from Newport. Current maxima of approximately 5 kts are to be found in from or to the west of the western edge of the meander. This "core" of the current may be 20-30 nm in from the edge.

The altimetry based model data also favor a track Newport to Bermuda to the west of the rhumb line, at the present time. The warm mass however, appears to be less of a concern than indicated by the SST image since modeled currents near the rhumb line are mainly east-west. This would allow a near rhumb line track to the vicinity of 39° N with a slight divergence west to offset the effects of the west to east flow along the northern edge of the warm water mass and the east to west along the southern margin. Looking further south, boat and wind conditions will ultimately dictate the advisability of a more westerly track to better take advantage of the currents in the western limb of the meander. It may be that for some the increase in distance to Bermuda that must be accommodated in order to reach the core of the current will not be justified. With the model showing a counter clockwise feature centered in the vicinity of 37° N 67° 30' W near the bottom of the meander currents on the order of 3kts are to be expected within much of the area 30 nm west of the rhumb line. Although these values are lower than the maxima the associated reductions in distance to the finish may justify a smaller departure from a rhumb line course. Of course, as the surprising and rapid evolution of Stream features have shown over the past three weeks, the factors governing strategic decisions may well change before the start of the Race in 10 days. Continuing and close examination of Stream characteristics is clearly warranted over this critical period.

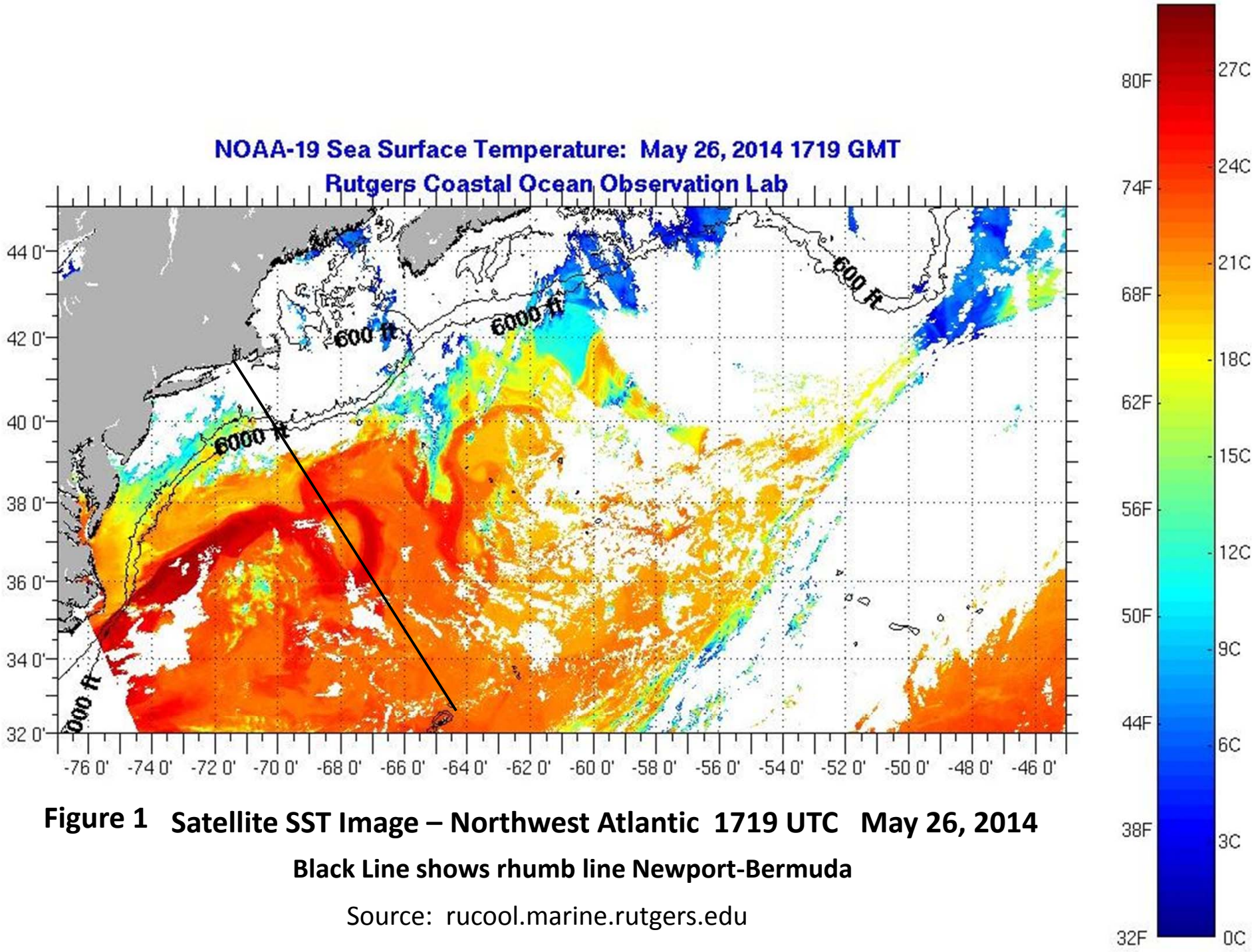

Figure 1 Satellite SST Image – Northwest Atlantic 1719 UTC May 26, 2014

Black Line shows rhumb line Newport-Bermuda

Source: rucool.marine.rutgers.edu

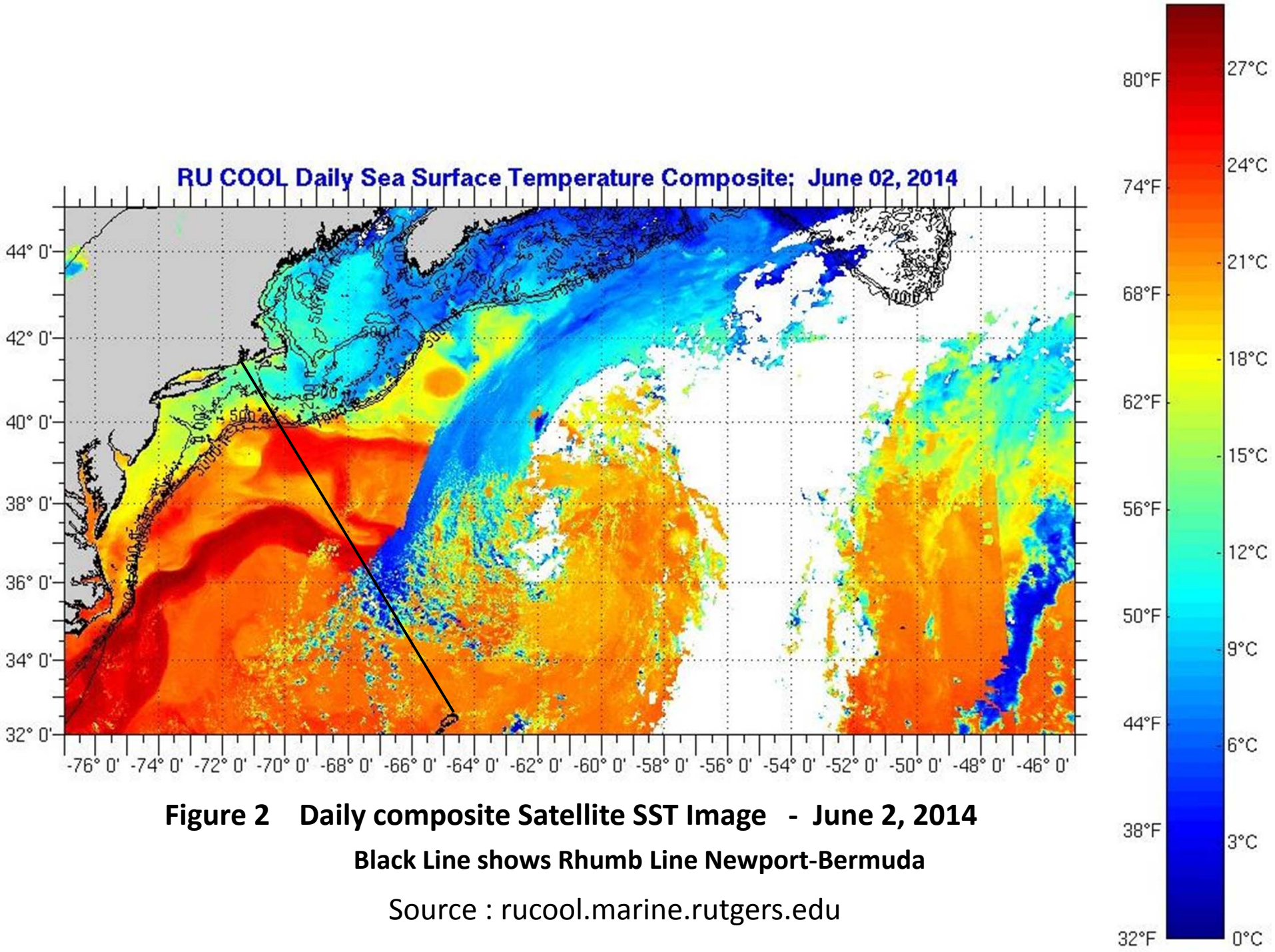

Figure 2 Daily composite Satellite SST Image - June 2, 2014

Black Line shows Rhumb Line Newport-Bermuda

Source : rucool.marine.rutgers.edu

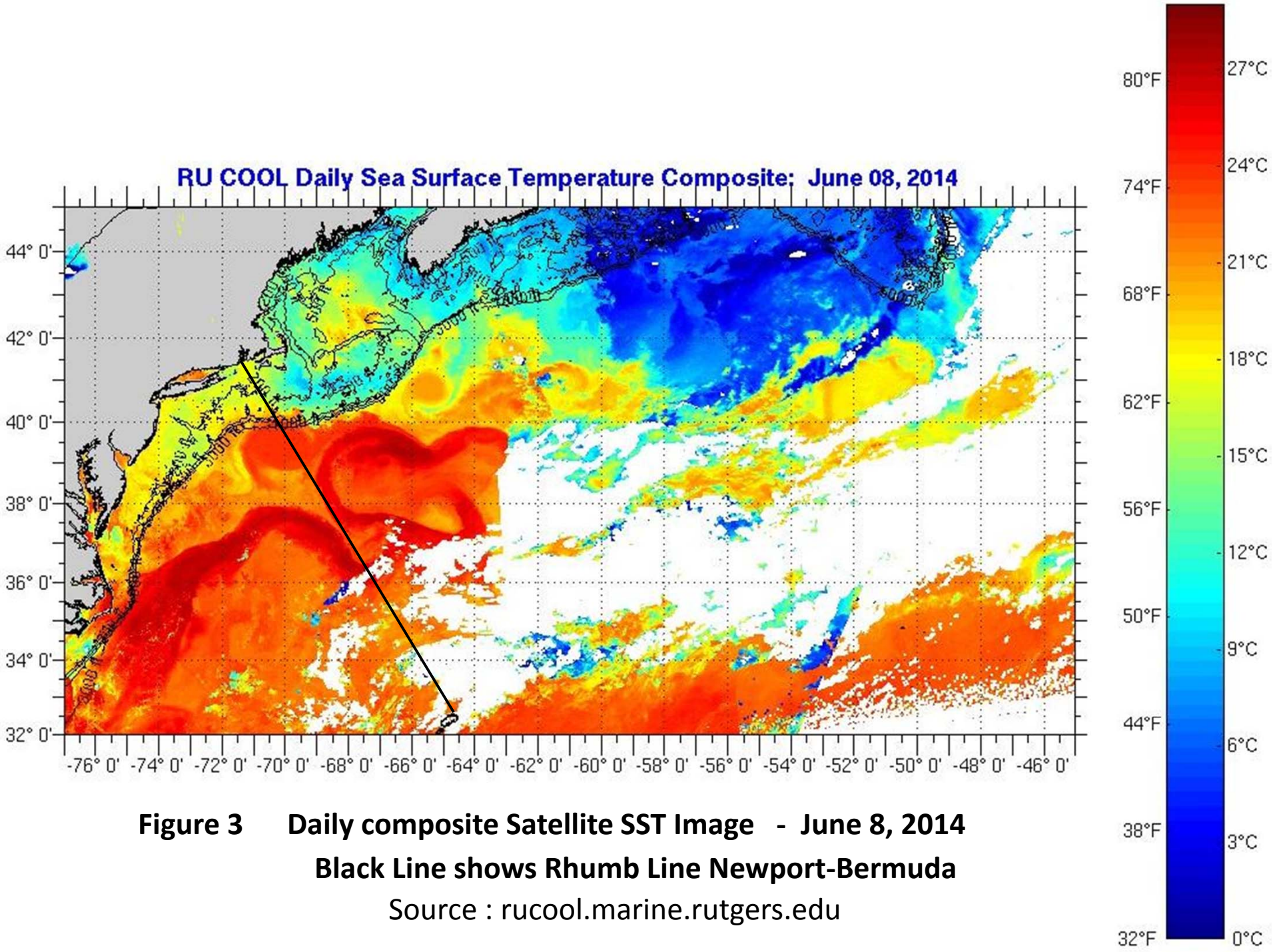

Figure 3 Daily composite Satellite SST Image - June 8, 2014

Black Line shows Rhumb Line Newport-Bermuda

Source : rucool.marine.rutgers.edu

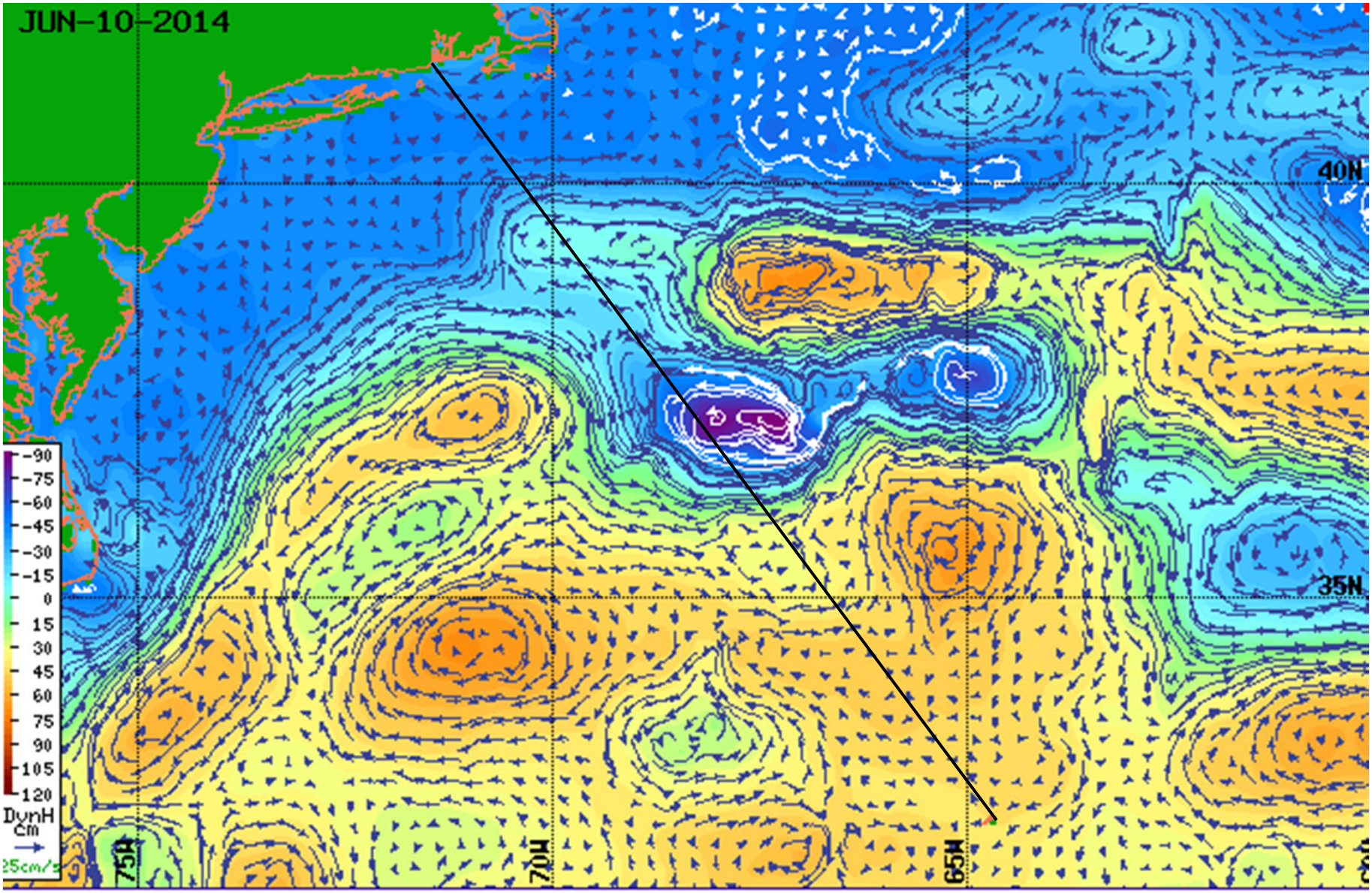

Figure 4 Satellite Altimetry Derived Surface Currents – NW Atlantic Region – June 10, 2014

Black Line shows Rhumb Line Newport-Bermuda

Source: http://www.aoml.noaa.gov/phod/dataphod/work/trinanes/INTERFACE/index.html