Gulf Stream Note #1- 2015
The Gulf Stream in the Vicinity of the Rhumb Line Newport to Bermuda May 5, 2015
An Analysis of Conditions

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With the start of the Bermuda 1-2 on June 5 it's time to start looking seriously at the Gulf Stream, its location, structure and probable evolution over the next 4-5 weeks. Those planning to participate in the Marion Bermuda Race (starting on June 19) have a bit more time but are also encouraged to begin systematic study of the Stream. There is after all no guarantee that cloud conditions will provide more frequent clear satellite views than have been available over the past two months. During this period clear views were available about once a week on average. Since there is little reason to believe that this will change significantly in May-June it seems advisable to take advantage of every opportunity to obtain clear satellite images. Such images are much to be preferred to any computer model based representation. This study is advisable whether or not you might employ a professional service since it makes you a well informed client better able to ask useful questions. Study also assists in the assessment of conditions encountered during the Race that differ from those expected. Such differences are all too frequent occurrences.

When last discussed in mid-March the Gulf Stream as seen in a composite satellite image of sea surface temperatures (http://marine.rutgers.edu/cool/sat_data/?nothumbs=0) displayed an unusually prominent meander pattern which resulted in the main body of the Stream crossing the Newport-Bermuda(NB) rhumb line at a point approximately 280nm from Newport (Fig.1). Flows across the line proceeded from the northwest to the southeast. Stream width was approximately 50 nm and there appeared to be a reasonably well defined cold core feature just south of the main body of the Stream. This feature or ring showed as an ellipse centered near 36^{o} 30' N 68^{o} 35' W. Under normal circumstance the meander would be expected to migrate slowly to the northeast at 10-20 nm/day, towards Europe, changing its position and orientation relative to the rhumb line. The ring, clear of Stream influence would drift slowly to the west, towards Cape Hatteras (0.1 kt ~ 2.4nm/day). Such changes have the potential to significantly affect optimum routing strategies.

Over the next two weeks there was generally dense cloud cover limiting satellite views of the Gulf Stream region. A composite image obtained on the 31^{st} of March (Fig.2) showed the main body of the Stream crossing the rhumb line at a point approximately 240 nm from Newport, still quite a ways offshore. The crossing proceeded at a near right angle with flows at the rhumb line proceeding from the west towards the east. This composite image showed little indication of a cold core ring suggesting that the earlier pattern might have been an artifact of the compositing process. This is one of the primary reasons that I favor use of single satellite images taken at a discrete time whenever possible. An alternative reason for the absence of the cold ring in the 31 March composite is that its presence in the SST signal is obscured by a surface layer of warmer water which has moved over the cooler, more dense, ring water. Such masking is not unusual and often affects detection of cold core features using the surface

temperature data (SST). At this point then the possibility of a cold core ring near the rhumb line should not be dismissed. There is some slight indication of a cold ring near 36° 15' N 67° 45' W but again it may be an artifact. It is clearly advisable to keep the possibility of this type of a feature being real in mind in subsequent analyses.

The observed evolution of the meander over the period 12-31 March provides graphic indication of the complexity of the meandering process. A simple migration of the wavelike feature to the northeast did not occur. Instead the main limb to the west of the NB rhumb line deepened significantly and moved slightly to the WEST increasing its distance from the rhumb line (Fig.2). Overall the entire feature moved slightly closer to the edge of the continental shelf while displaying minimal northeasterly migration. This response points to the value of frequent satellite observation in the interest of accuracy and minimum use of assumptions.

Continuing our observations into April, the composite image of the 12th (Fig.3) shows an evident northeasterly migration of the main limb of the meander with the northwest to southeast tending portion moving closer to the rhumb line (approximately 50nm to the west) resulting in the formation of a prominent trough to the west of the rhumb line. The main body of the Stream abruptly changes direction at this trough and then crosses the rhumb line from the southwest to the northeast. This pattern favors routes to Bermuda well to the west of the rhumb line to minimize or eliminate the effects of adverse flows. The image shows no indication of cold or warm core rings in the vicinity of the rhumb line.

The pattern observed on 12 April remained essentially in place through the end of the month. The composite of 4 May (Fig.4) shows some consolidation of the limb to the west of the rhumb line but little change in position of the trough. The separation between the northwest-southeast tending limb and the rhumb line is slightly reduced (now approximately 45nm). The main body of the Stream crosses the rhumb line at a point approximately 270 nm from Newport with flows proceeding from the southwest to the northeast. This slight reduction in distance relative to early April is accompanied by some mixing of warm Stream water with the cooler inshore waters ,shown as slightly cooler water near the trough. This mixing has the potential to produce some local flows proceeding to the southwest along the northern edge of the patch. Such local flows often confuse the navigator on approach to the Stream. They generally are weak (<1.5kts) and shortlived.

To the north of the main body crossing of the rhumb line the composite shows several patches of warmer water which, being clear of Stream influence, clearly have the potential to become more consolidated forming a well defined warm core ring. The most evident is centered near 39° 15' N 69° W bordering the rhumb line. An examination of the U.S. Navy sea surface temperature (SST) plot for 4 May (Fig.5) indicates a defined warm core ring (W1506) to the west of the above position already clear of the rhumb line. This interpretation seems at odds with the pattern shown on the composite image. The reason for this difference is not immediately apparent.

Resolution of differences in interpretation is best accomplished using yet another set of data. One of the most useful pieces for this is provided by the NOAA developed altimetry based model (http://www.aoml.noaa.gov/phod/dataphod/work/trinanes/INTERFACE/index.html) of ocean currents. I typically rely on this product primarily during periods of dense cloud cover. The altimetry is obtained using radar which is insensitive to cloud cover. As a result this product is continuously available. It has proven to be the most useful model for Stream evaluation.

The altimetry based model results (Fig. 6) for the 6th of May (a two day delay is required to allow for processing time- Altimetry was obtained on the 4th) provide only slight evidence of a ring near 37° 30' N 69° W as indicated on the Navy plot (Fig.5). The most significant rotation along the rhumb line at this time is in the vicinity of the trough in the area affected by mixing of warmer water shed from the main body of the Stream as shown in the composite (Fig. 4). The altimetry results do suggest that formation of a more well defined feature is possible near 39° 30' N 71° W. If this does form it's likely to drift west over the next few weeks unless quickly dissipated by the shoaling depths along the edge of the continental shelf. If the Stream retains its present form, dominated by a meander just west of the rhumb line, the presence of a warm core ring near 71° W has the potential to add to the benefit of a route to Bermuda well to the west of the rhumb line. We should be looking for such development in our future analyses.

The above analysis has placed primary emphasis on satellite observations. Model results were discussed only briefly and used in comparison to the satellite observations. Since many of the current routing programs (e.g. Expedition) rely almost entirely on models such as the NOAA Real Time Ocean Forecast System (RTOFS) (http://polar.ncep.noaa.gov/) it's advisable to compare model results to the results provided here from the satellite observations as well as conducting an inter comparison of the altimetry based model with RTOFS. We will talk abit more about the place of models in routing in the next Note. For the moment it might be fun to consider what your route might be if you were starting tomorrow and the Stream retained the structure observed on the 4 May, composite. For winds, take look at the 24 hr forecast for starting conditions as well as those forecast for the next four days (96-120 hrs) for down course conditions. Visit the NWS website (http://www.nws.noaa.gov/om/marine/home.htm) and compare results to winds predicted by Passage Weather (http://passageweather.com/). Next, use the combination to consider the value of hunting for and hopefully taking advantage of 3-5 knots of current vs. a simple rhumb line course to Bermuda if the position of the core of the current requires a significant departure and adds significant distance. Enjoy !

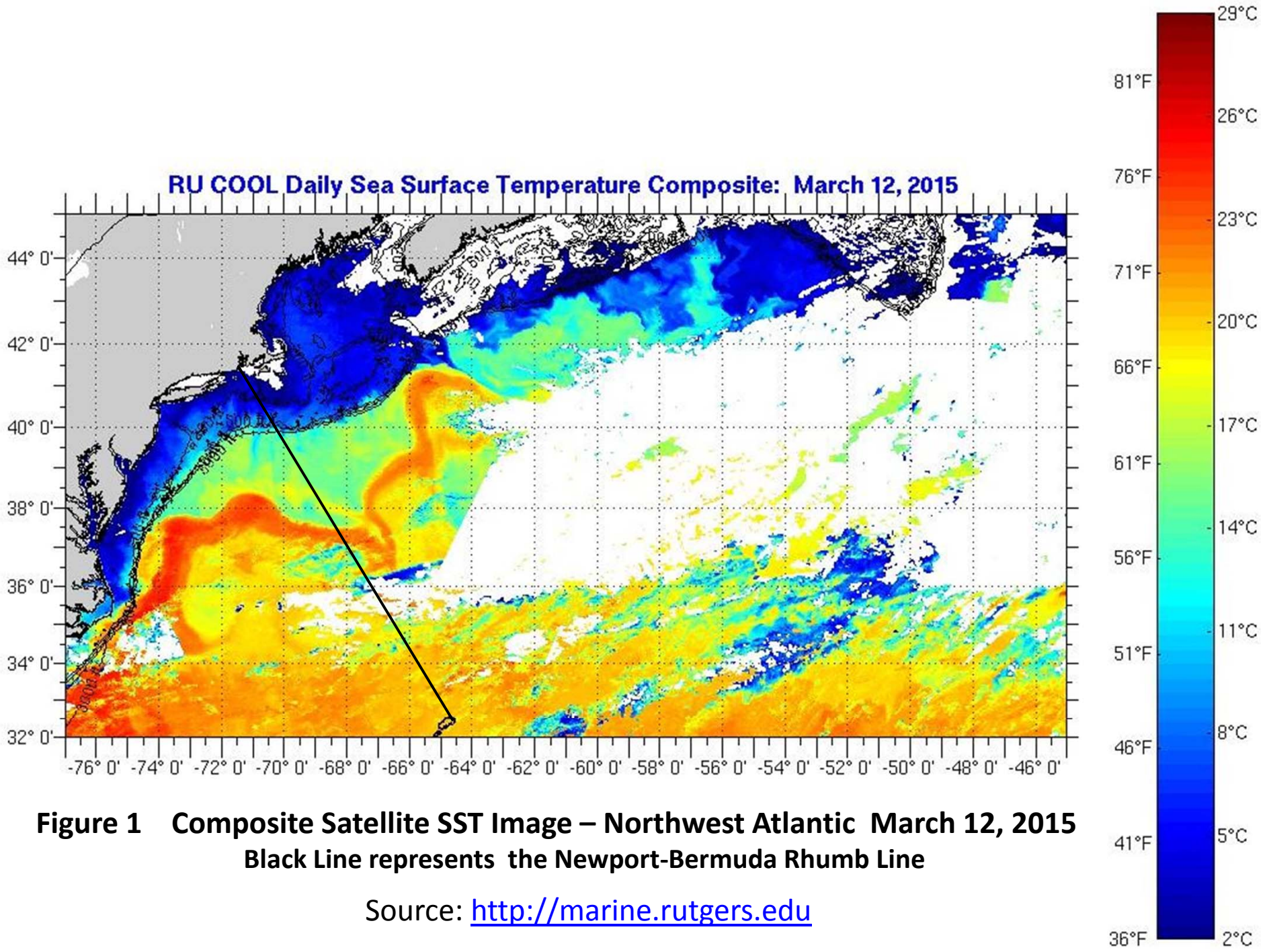

Figure 1 Composite Satellite SST Image – Northwest Atlantic March 12, 2015

Black Line represents the Newport-Bermuda Rhumb Line

Source: http://marine.rutgers.edu

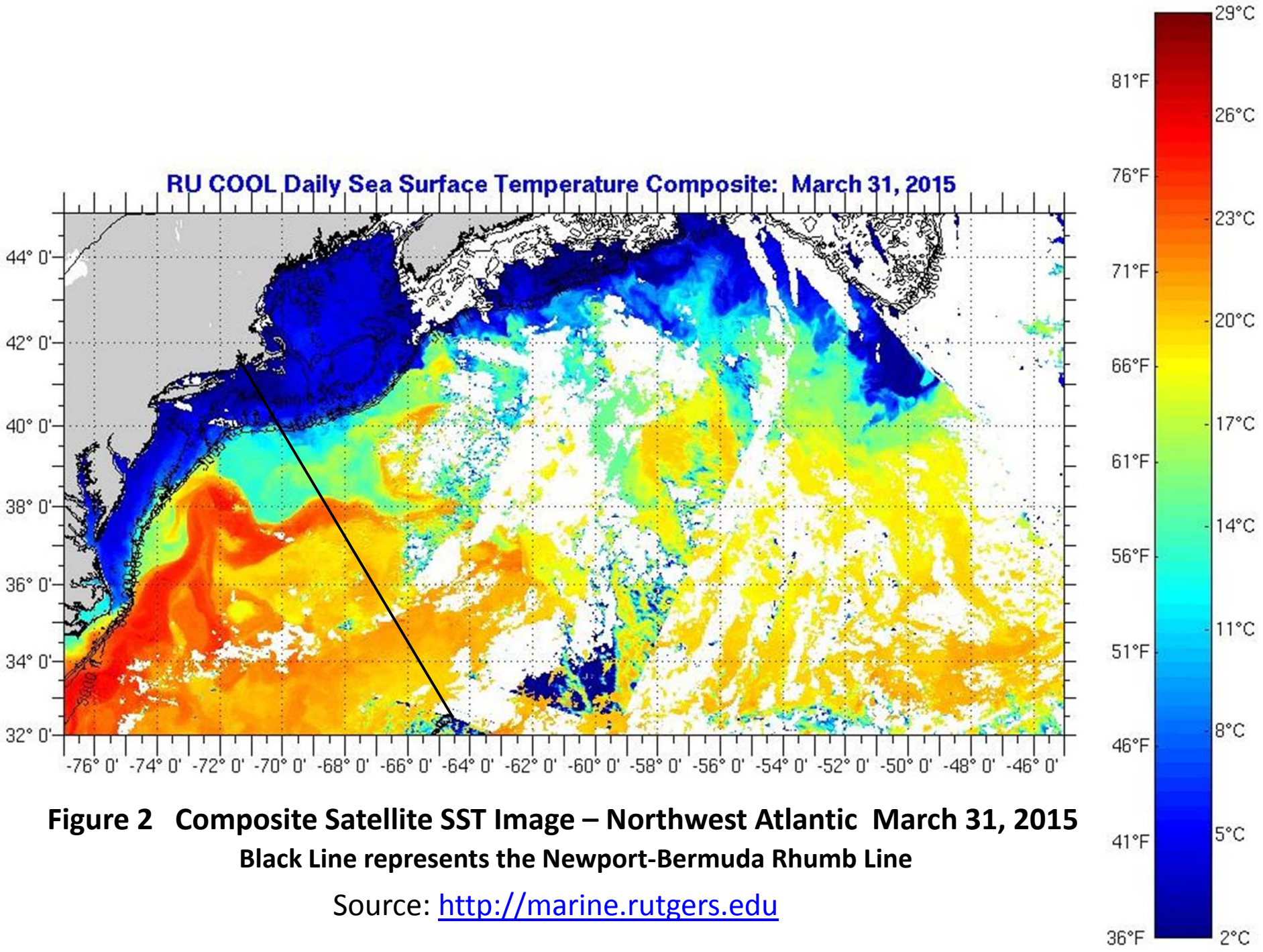

Figure 2 Composite Satellite SST Image – Northwest Atlantic March 31, 2015

Black Line represents the Newport-Bermuda Rhumb Line

Source: http://marine.rutgers.edu

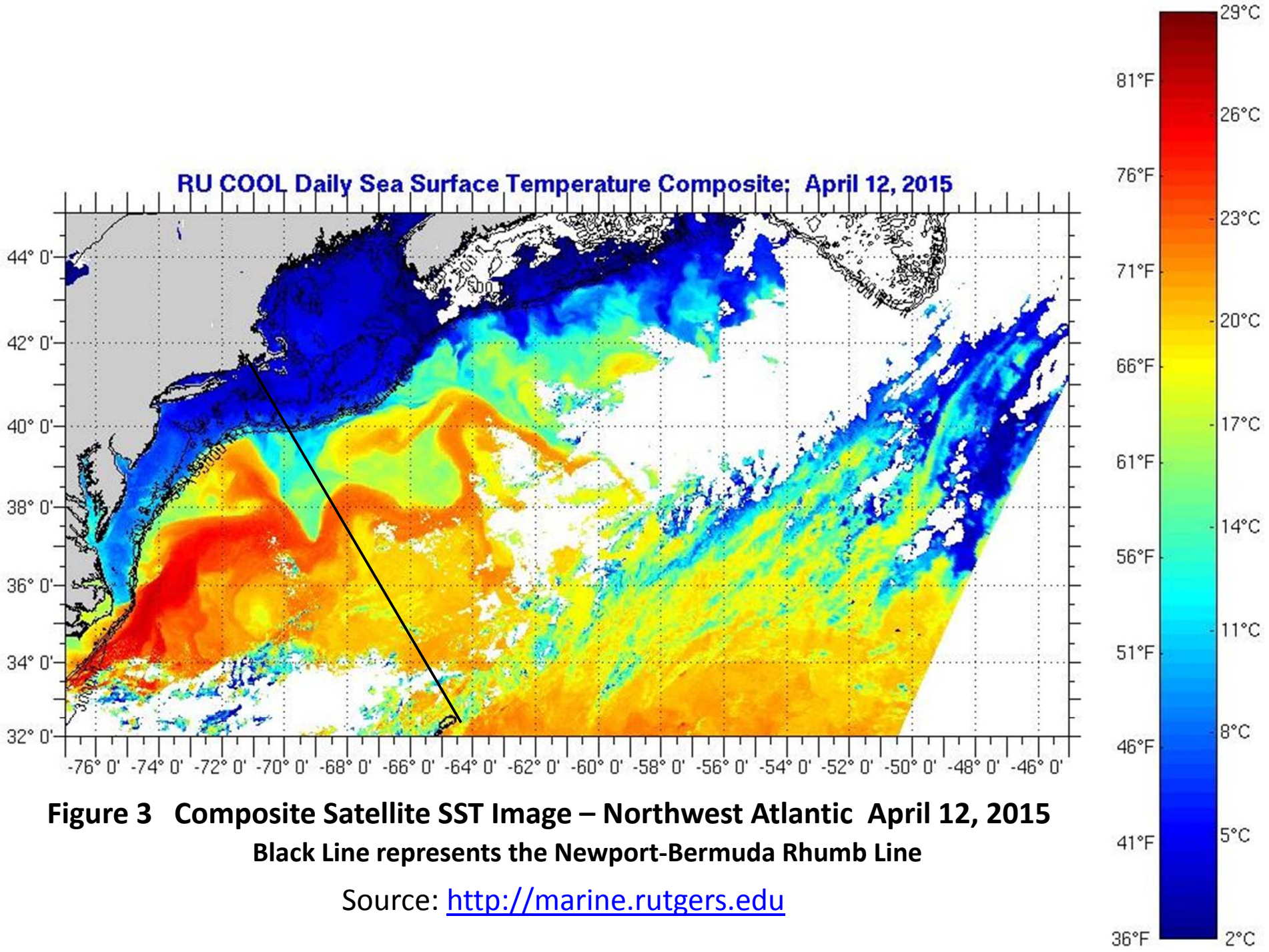

Figure 3 Composite Satellite SST Image – Northwest Atlantic April 12, 2015

Black Line represents the Newport-Bermuda Rhumb Line

Source: http://marine.rutgers.edu

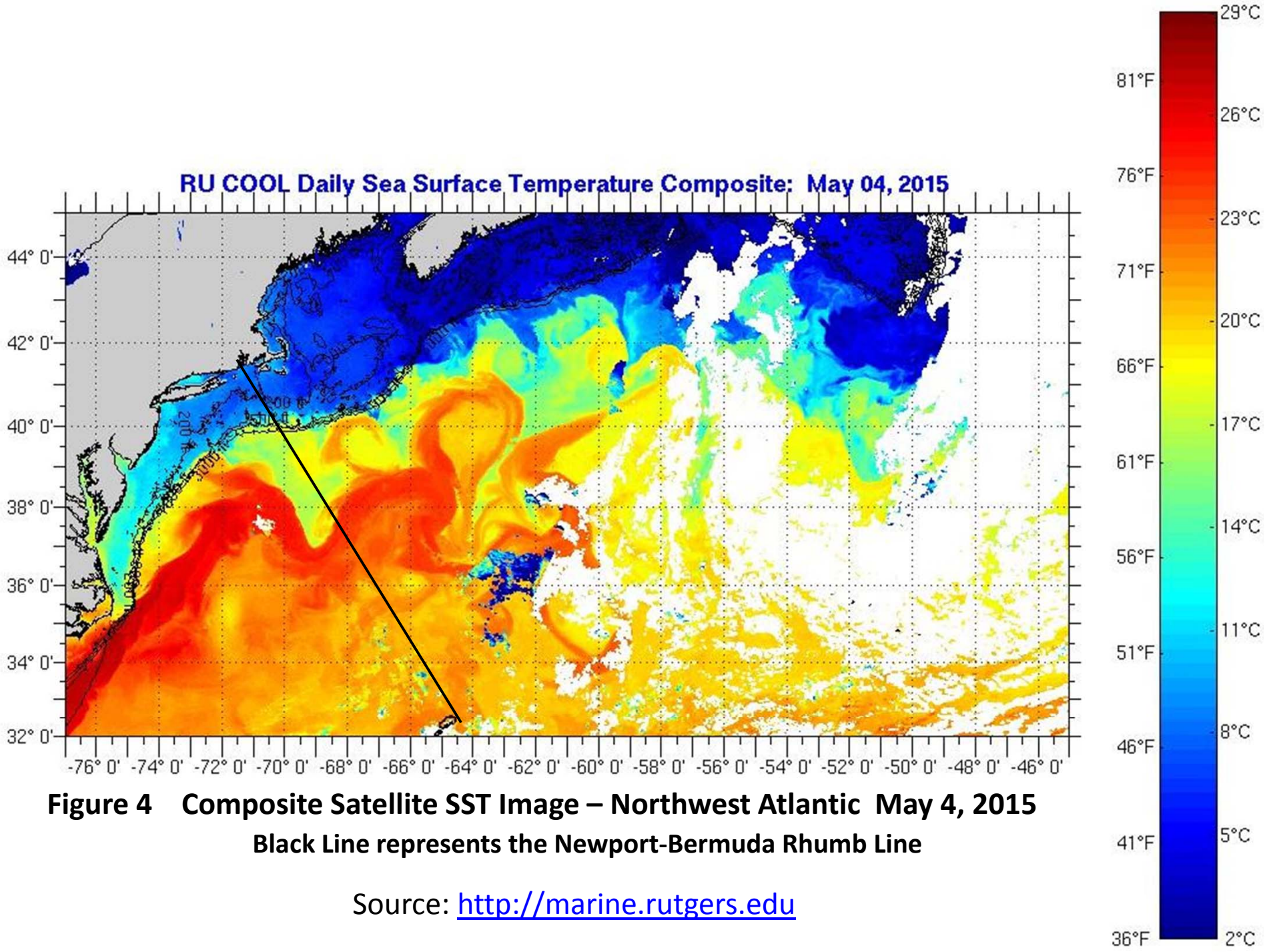

Figure 4 Composite Satellite SST Image – Northwest Atlantic May 4, 2015

Black Line represents the Newport-Bermuda Rhumb Line

Source: http://marine.rutgers.edu

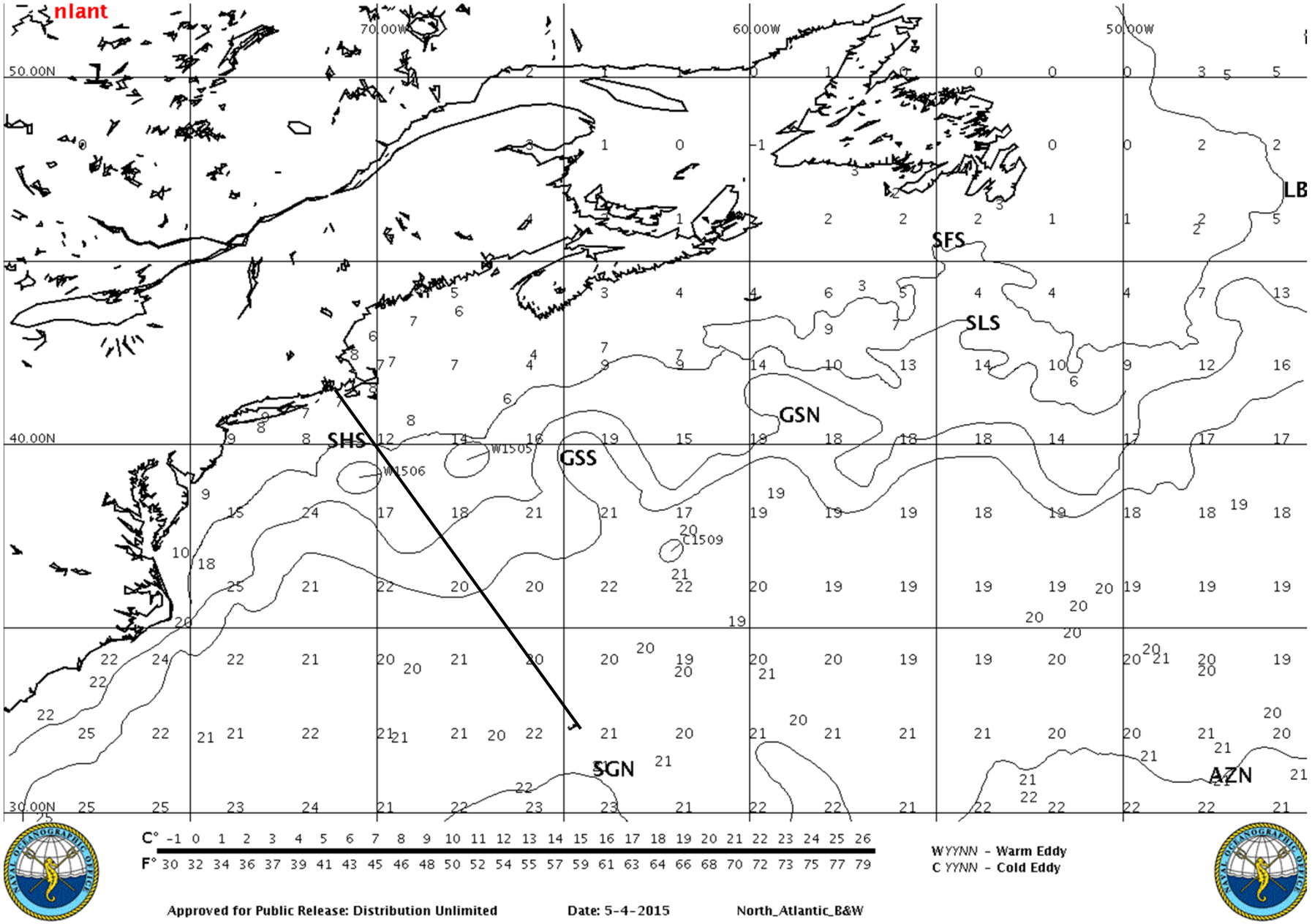

Figure 5 Northwest Atlantic Sea Surface Temperatures – U.S. Navy Product

Black Line Represents the Newport-Bermuda Rhumb Line

http://ecowatch.ncddc.noaa.gov/JAG/Navy/data/satellite_analysis/gsnofa.gif?id=3110

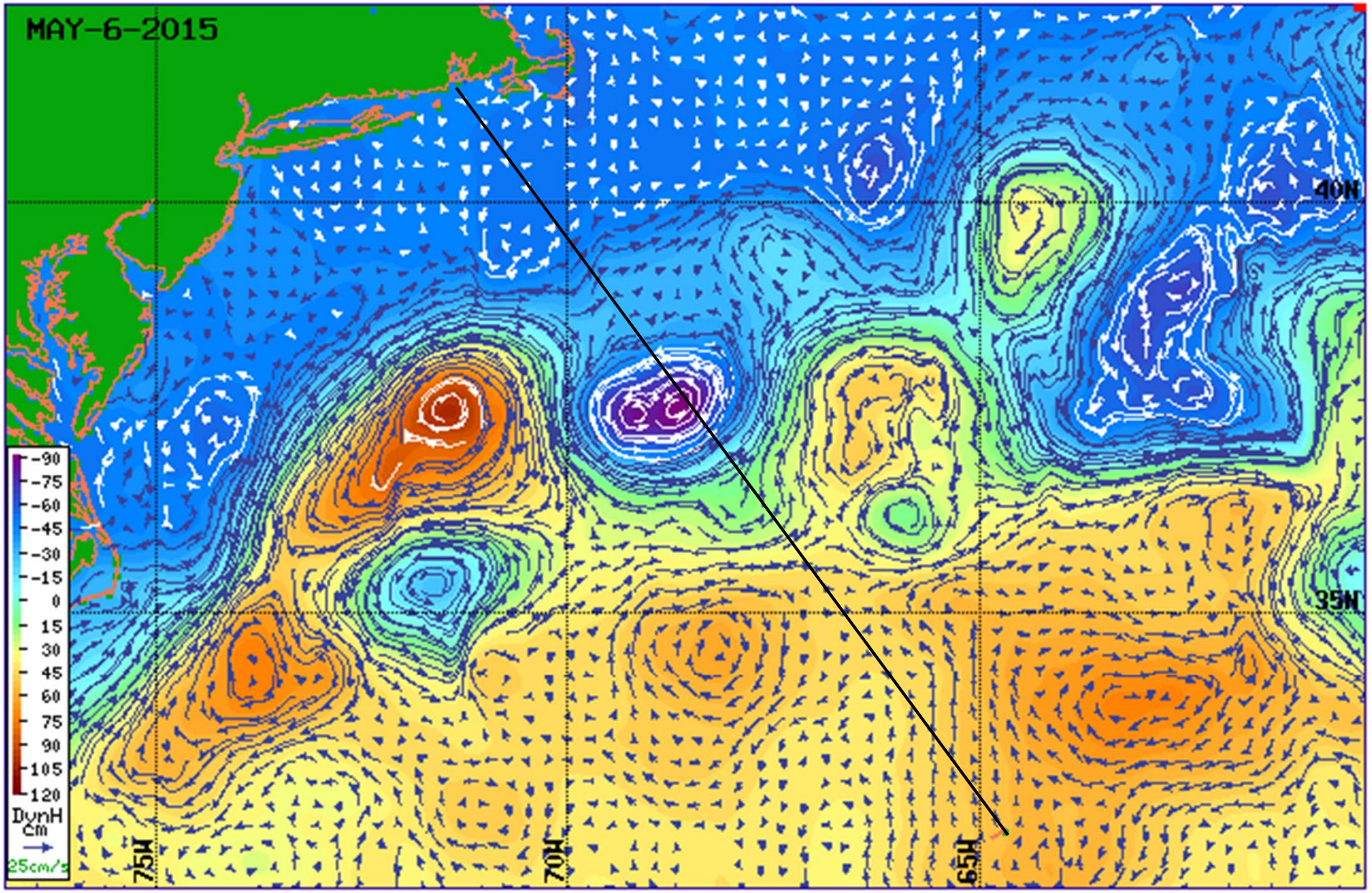

Figure 6 Satellite Altimetry Derived Surface Currents – NW Atlantic Region – May 6, 2015

Black Line Represents the Newport-Bermuda Rhumb Line

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