Gulf Stream Note #2

The Gulf Stream in the Vicinity of the Rhumb Line Newport to Bermuda May 30, 2015

An Analysis of Conditions

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With less than a week to go before the start of the Bermuda 1-2 I am sure that all competitors are beginning to look seriously at potential weather conditions for the start of the Race and considering routing options to take full advantage of Gulf Stream currents. Marion Bermuda competitors have some time to study weather but also should be carefully watching Gulf Stream conditions as they are undergoing some substantial changes with the potential to produce "interesting" conditions by the end of June and the start of the Race from Marion. In addition, as been often stated, early study is of particular value during this time of year due to the prevalence of cloud cover that often limits satellite views and affects interpretation. This has certainly been the case over the past month.

Since the 4th of May (see GS Note #1) the available satellite composite images of sea surface temperatures (SST) showed the meander crossing the rhumb line from the southwest to the northeast near 38° N apparently undergoing an unusual series of changes. Rather than the expected orderly progression or movement of this feature to the northeast it remained nearly stationary, narrowed and deepened and seemingly broke into pieces. The resulting SST patterns were difficult to interpret and could easily have been taken as indication of a breakup of the meander and the associated flow field. Careful examination of the satellite imagery over a period of time in combination with other data including model results indicated that this was clearly not the case. The meander remains in place but in a substantially narrower form. This narrowing favored some cross-meander migrations of warm water masses leading to short-lived complicated SST patterns confounding interpretation and probably introducing false images or artifacts into the compositing process. Analysis of such condition is clearly favored by longer rather than shorter periods of observation.

By the 27th of May (Fig.1) the meander extended well to the southeast approaching 35° 30' N. From the SST image it appears to be crossing the rhumb line from the northwest to the southeast near this point resulting in flows to the southeast west of the rhumb line. This image suggests that the optimum route to Bermuda in terms of Gulf Stream current is along a line approximately 30-40 nm to the west of the rhumb line.

The preferred route crosses a large area of water warmer than inshore but still cooler than the Stream beginning near the edge of the continental shelf (Fig.1). This was the area that showed some a possible warm core ring development in early May. The composite SST for 27

May provides no indication of such formation. However, examination of the U.S. Navy analysis for 29 May (Fig.2) does. The feature shown on the Navy plot has moved little since the beginning of the month. If it does exist it could provide some additional southerly flow within 10 to 15 nm west of the rhumb line with adverse currents to the north and northwest further to west. At this point prudence might favor consideration of this feature in route planning.

In addition to the possible warm core ring, the Navy plot provides another view of the meander and support for optimum routing to the west of the rhumb line. Remembering that the core of the Stream flow is located approximately 30nm from the northern (inshore) edge of warm water shown by the SST plot (GSN – as indicated on Fig 2) would suggest that that the core of the Stream crosses the rhumb line around 36^{o} N on the Navy figure.

Additional insight into the Structure of the Gulf Stream at this time is provided by several computer models. As discussed previously, I tend to favor NOAA's altimetry based model (http://www.aoml.noaa.gov/phod/dataphod/work/trinanes/INTERFACE/index.html). Allowing a two day delay for data processing, the model image provided for 29 May represents conditions observed by the satellite on May 27th. The resulting plot (Fig.3) shows a prominent meander virtually centered on the rhumb line. The narrowing and elongation relative to conditions observed in early May is evident. This analysis shows Stream associated flows crossing the rhumb line in the vicinity of 36^{o} N 67^{o} 30'W proceeding from west to east. In its present form racers to Bermuda could encounter south going currents at a point approximately 200nm from Newport near 38^{o} 30'N 69^{o} 30'W approximately 35 west of the rhumb line. Routing to this point should avoid any negative effects from the possible warm core ring discussed above although the altimetry provides no indication of warm core development in this area.

Another series of models provided by NOAA solves the basic equations of fluid motion to compute temperature distributions and associated currents. Several of these are used in popular routing programs such as Expedition. It is useful to compare the predictions provided by these models to the same time satellite SST imagery (such as Fig 1) and/or the altimetry based model (Fig 3). For their Global Real Time Ocean Forecast System (RTOFS) NOAA also provides comparisons with the Navy analysis of the Gulf Stream (Fig.2). The results are shown on Figure 4.

The RTOFS model provides 1/12^{o} degree spatial resolution meaning that there is one computed value every five nautical miles. As a result it may not be surprising that there are differences between each of the analyses. Experience indicates that the combination of direct satellite views and the altimetry based model provides the best indication of Stream structure for the small boat navigator. However if one of these is missing or if the system used on your boat requires digital inputs such as GRIB based data then serious consideration must be given to RTOFS. For the present conditions it looks to provide a reasonable simulation of the western portion of the meander, discussed above, with some eastern displacement. Even with this

displacement however, the model result would support routing west of the rhumb line to Bermuda with an offset of at least 30nm. That is more or less the same conclusion developed using the satellite composite image and the altimetry based model. The simulation appears to break down to the east severely limiting its utility for a Newport bound boat. It seems clear that the use of such models requires care and study to determine strengths and weaknesses. Despite seductive utility in digital systems the models often have their limitations when it comes to small boats routing.

Enjoy the week. The next Note will be provided at the Bermuda 1-2 Skipper's Meeting.

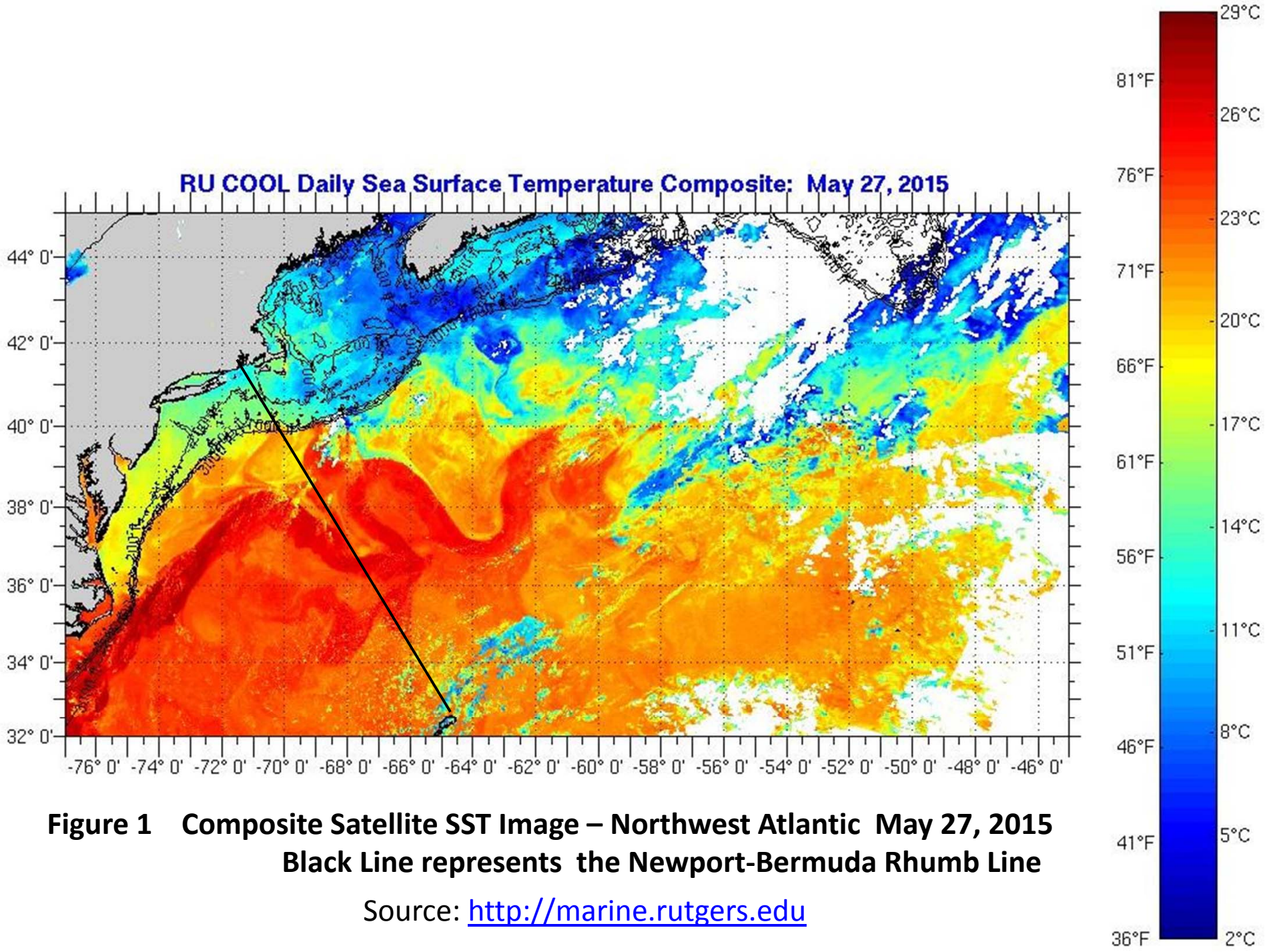

Figure 1 Composite Satellite SST Image – Northwest Atlantic May 27, 2015
Black Line represents the Newport-Bermuda Rhumb Line

Source: http://marine.rutgers.edu

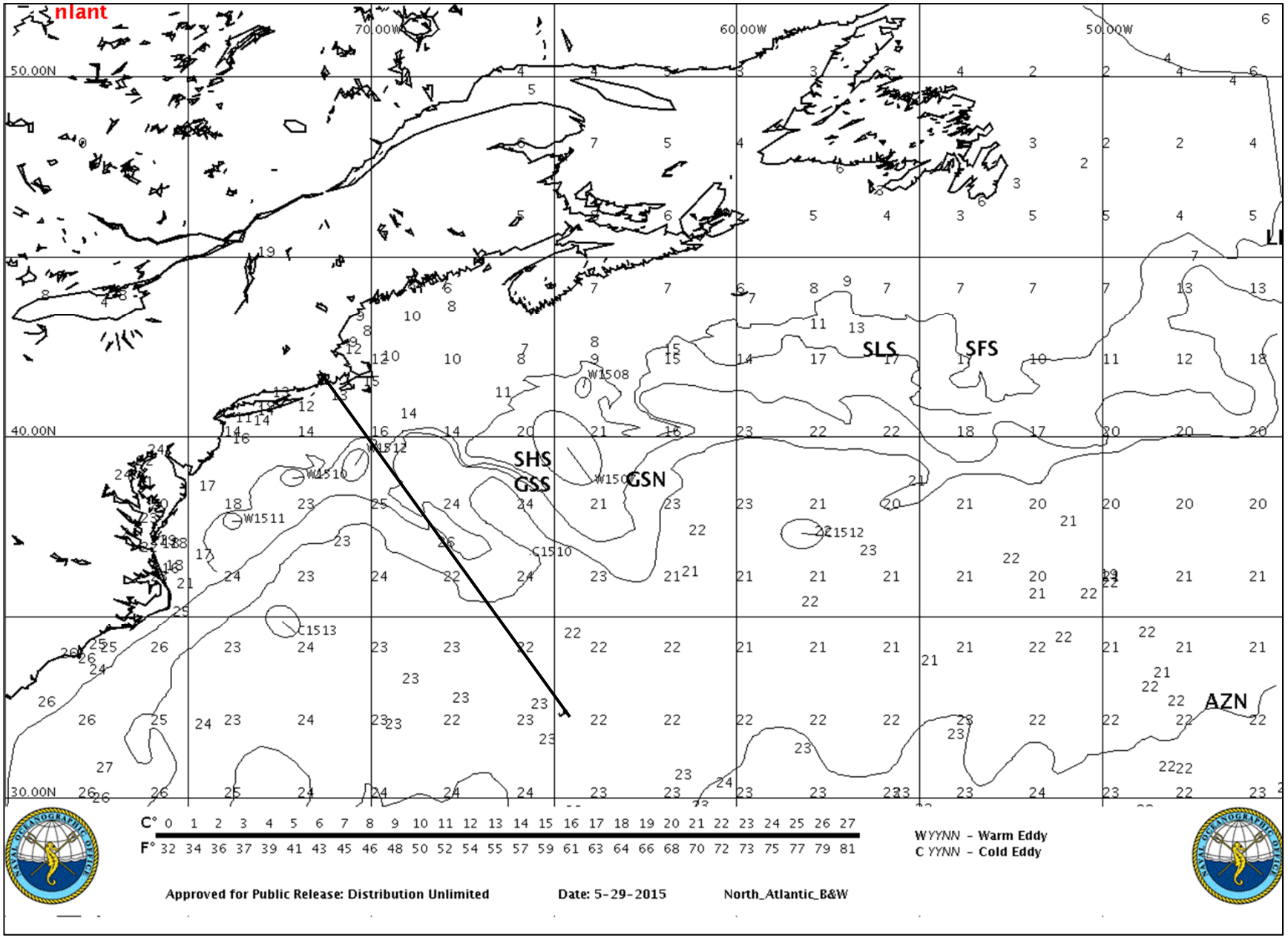

Figure 2 Northwest Atlantic Sea Surface Temperatures – May 29, 2015 – USN Product

Black Line Represents the Newport-Bermuda Rhumb Line

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

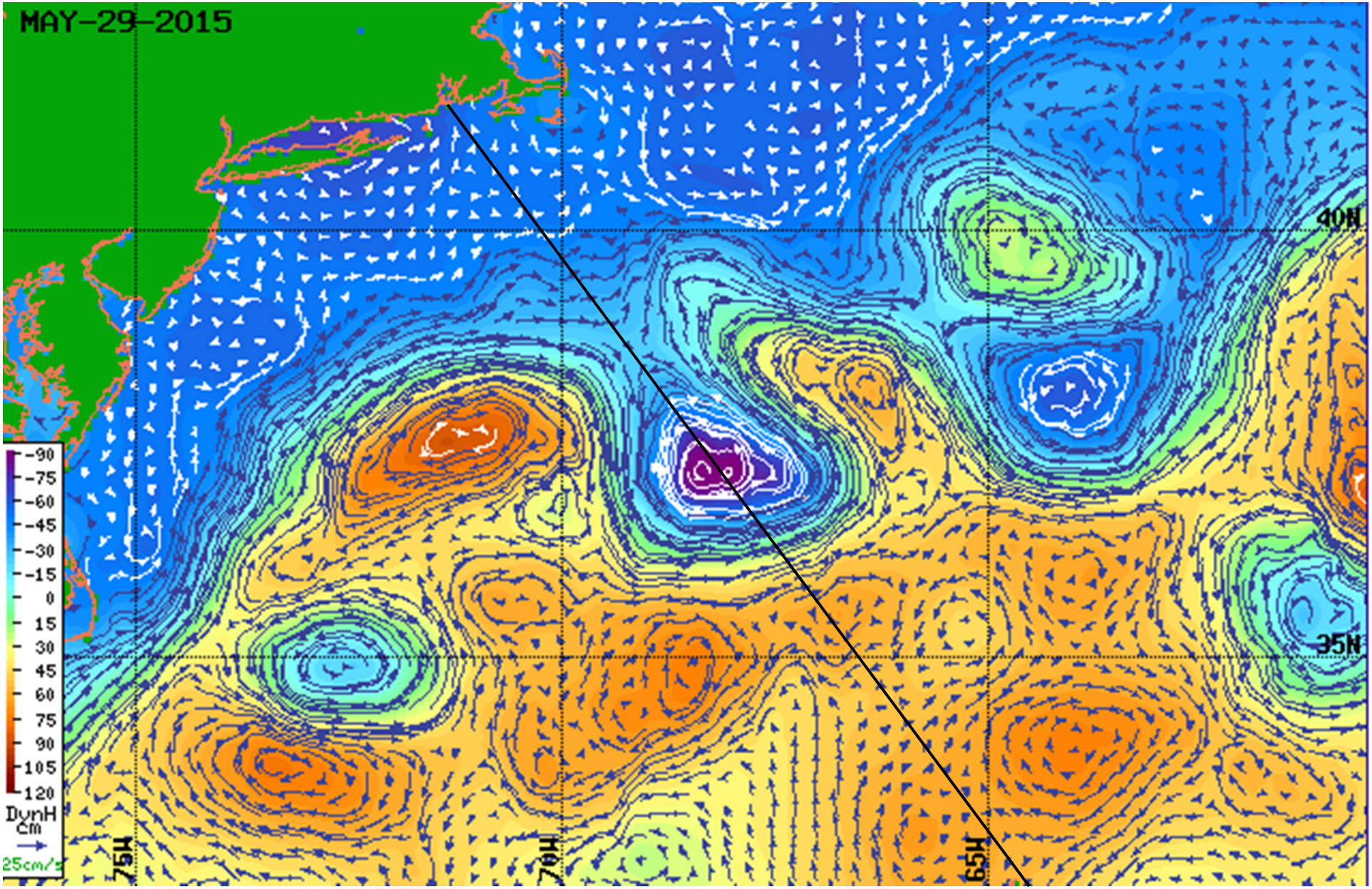

Figure 3 Satellite Altimetry Derived Surface Currents – NW Atlantic Region – May 29, 2015

Black Line Represents the Newport-Bermuda Rhumb Line

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

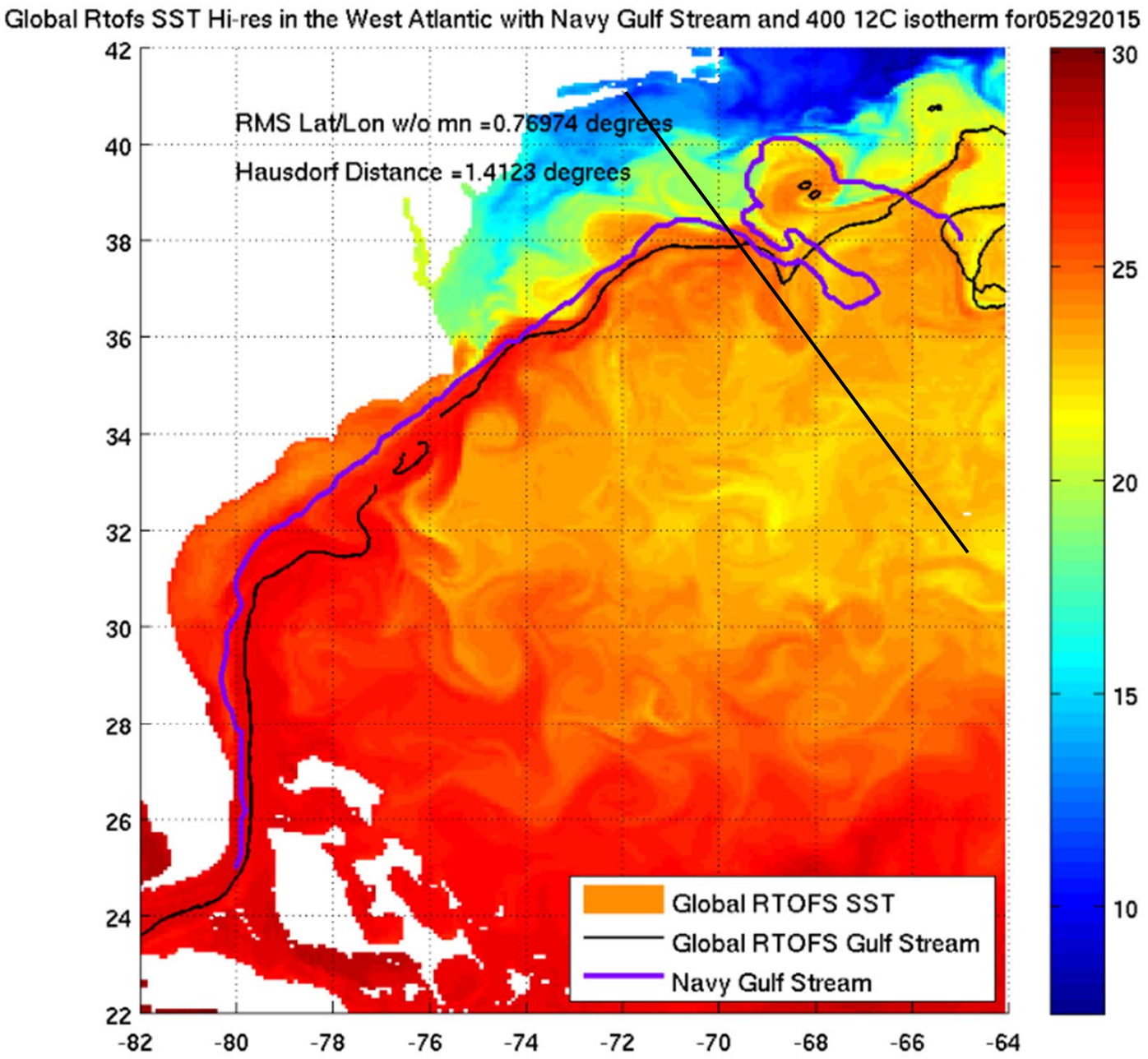

Figure 4 NOAA Computer Model with Comparisons

http://www.opc.ncep.noaa.gov/sst/images/gulfstream/GScomp_GRtofs.png