The Gulf Stream Near the Rhumb Line Newport-Bermuda May 31, 2016

An Analysis of Conditions

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Over the past two to three weeks the Gulf Stream in the vicinity of the Newport to Bermuda rhumb line has continued to be dominated by a relatively large amplitude meander in combination with an interesting circular region of warm water along the northern margin of the main body of the Stream and a possible cold core feature to the south. Between 9 May and 17 May the meander migrated to the east and deepened slightly so that it now was in close contact with the rhumb line resulting in favorable (for those enroute Bermuda) south going currents influencing more than 90nm of the rhumb line (Fig. 1). (Note: This image is from the Rutgers University site. This site has been reconfigured over the past several weeks. The SST satellite images can be found by entering the site; scrolling down to *Live Ocean Data*; and then entering the *Real Time and Archived Satellite Imagery*). The circular mass of warm water appeared to be clear of direct Stream influence and was migrating to the west, towards the rhumb line, along the edge of the continental shelf. Despite the appearance of a colder core the temperature and associated water column densities in this feature favor clockwise rotation characteristic of a warm core ring.

From the 17th of May to 28 May migration of the meander slowed accompanied by a slight anti-clockwise rotation of the main body of the Stream resulting in flows across the rhumb line becoming progressively more northwest to southeast (Fig. 2). The warm water feature made contact with the Stream near 38^{o} 30' N 69^{o} W and is likely to be further entrained over the next few weeks. The SST images continue to provide little indication of a cold core feature south of the main body of the Stream. Resolution of the presence or absence of this feature requires reliance on computer models such as those discussed in my article that appeared in this year's Race Program.

The altimetry based model for the 30th (http://www.aoml.noaa.gov/)(two day delay to allow for data reduction) provides clear indication of the position of the northern margin of the Stream (sometimes referred to as the North Wall) and the entrainment of the warm water mass (Fig.3). Flows in this region across the rhumb line appear to be more complicated that the

SST image would imply with currents rapidly changing direction on crossing the rhumb line. Overall, flow directions are favorable to Bermuda to the vicinity of 37^{o} N 68^{o} 15' W where core current direction abruptly deviates to the west resulting in a large area of counterclockwise (CCW) flow centered near 36^{o} N 69^{o} W. The model results show this circular feature to have a diameter of more than 120nm. The position and extent of this feature complicates optimum routing since it is possible that depending on wind conditions as well as boat type a near rhumb line course might be optimum despite the probability of adverse northerly flows over a distance of approximately 90nm. It's also possible that this feature will move further west over the next two weeks if it breaks free of the influence of the main body of the Stream which would favor significant alterations in the structure of the meander and affect optimum routing decisions.

An alternative to the altimetry based model of ocean currents is the Global Real Time Ocean Forecast System (http://polar.ncep.noaa.gov/global/monitor/) which provides output in GRIB format and is used in many computer based optimum routing applications. The SST patterns provided by this model for the 29th of May (Fig.4) show reasonable agreement with the Rutgers satellite IR image of the 28th (Fig.2). For those of you planning on using RTOFS such comparisons should be routinely done. There are many occasions when the model-satellite image differences are substantial. In this case the structure and positioning of the Stream shown by the IR SST image and the model output are essentially identical and both show the warm water feature north of the Stream. The model SST output gives no indication of a cold core feature west of the rhumb line south of the Stream. The associated current pattern provided by RTOFS (Fig.5) however, does show some structure south of the Stream at a location similar to that of the CCW rotating feature on Figure 3 although it is weakly defined and more nearly elliptical than circular in planview (see circled area Fig.5). The fact that both models show some organized flow structure in this area must be carefully considered in routing decisions. We will continue to watch this area over the next few weeks.

The observed rate of change in Gulf Stream structure over the past three weeks suggests that it is likely that the conditions during the Race will be similar to those today. It seems unlikely that the meander will breakdown although such rapid change is possible. Similarly, it seems unlikely that the migration of the CCW rotating feature south of the main body of the Stream will be sufficient to eliminate its influence along the rhumb line. This is the combination of Stream characteristics that should be closely watched in order to allow development the most efficient routing strategy as the actual weather and wind conditions for the period of the Race become known.

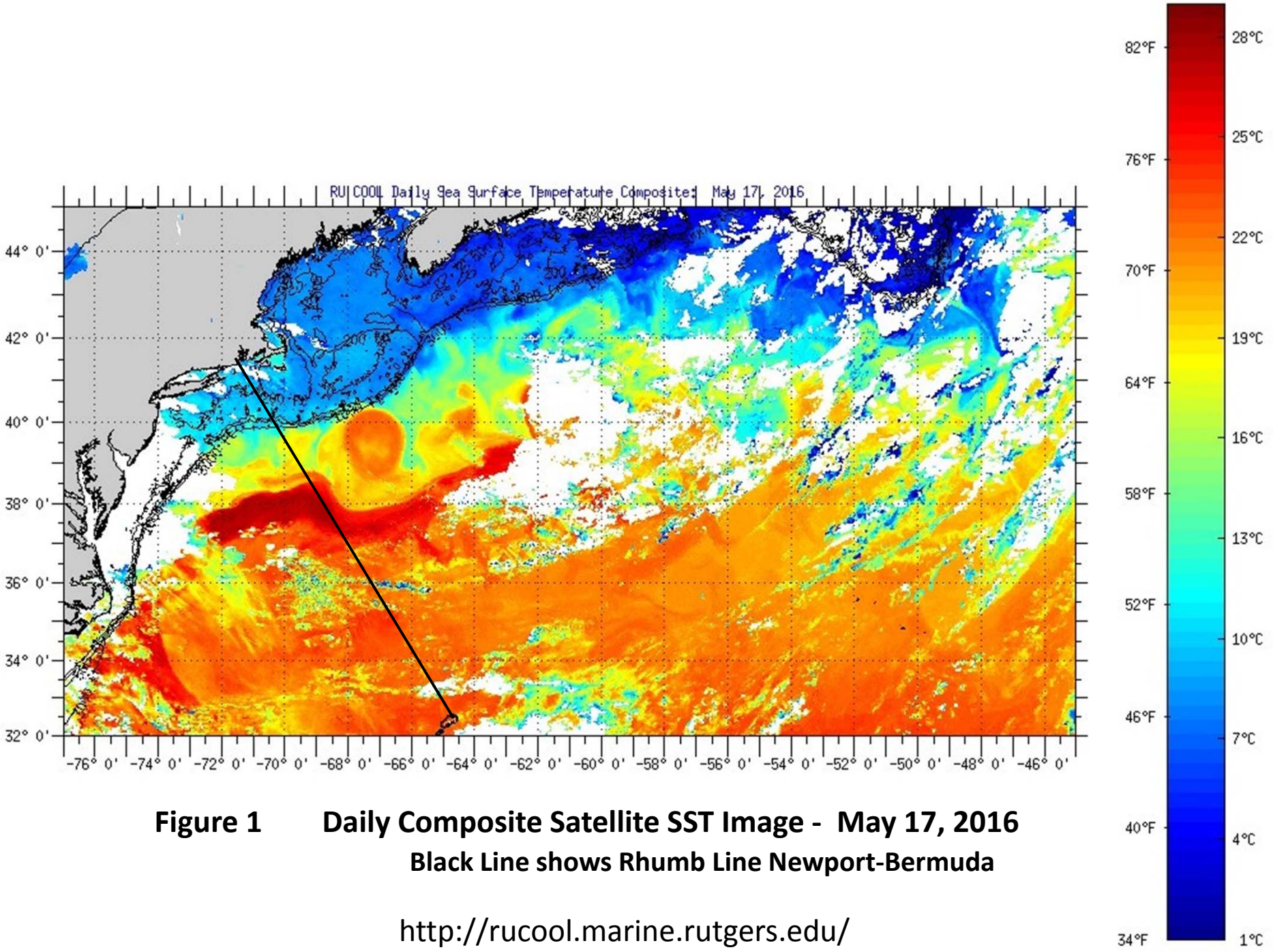

Figure 1 Daily Composite Satellite SST Image - May 17, 2016

Black Line shows Rhumb Line Newport-Bermuda

http://rucool.marine.rutgers.edu/

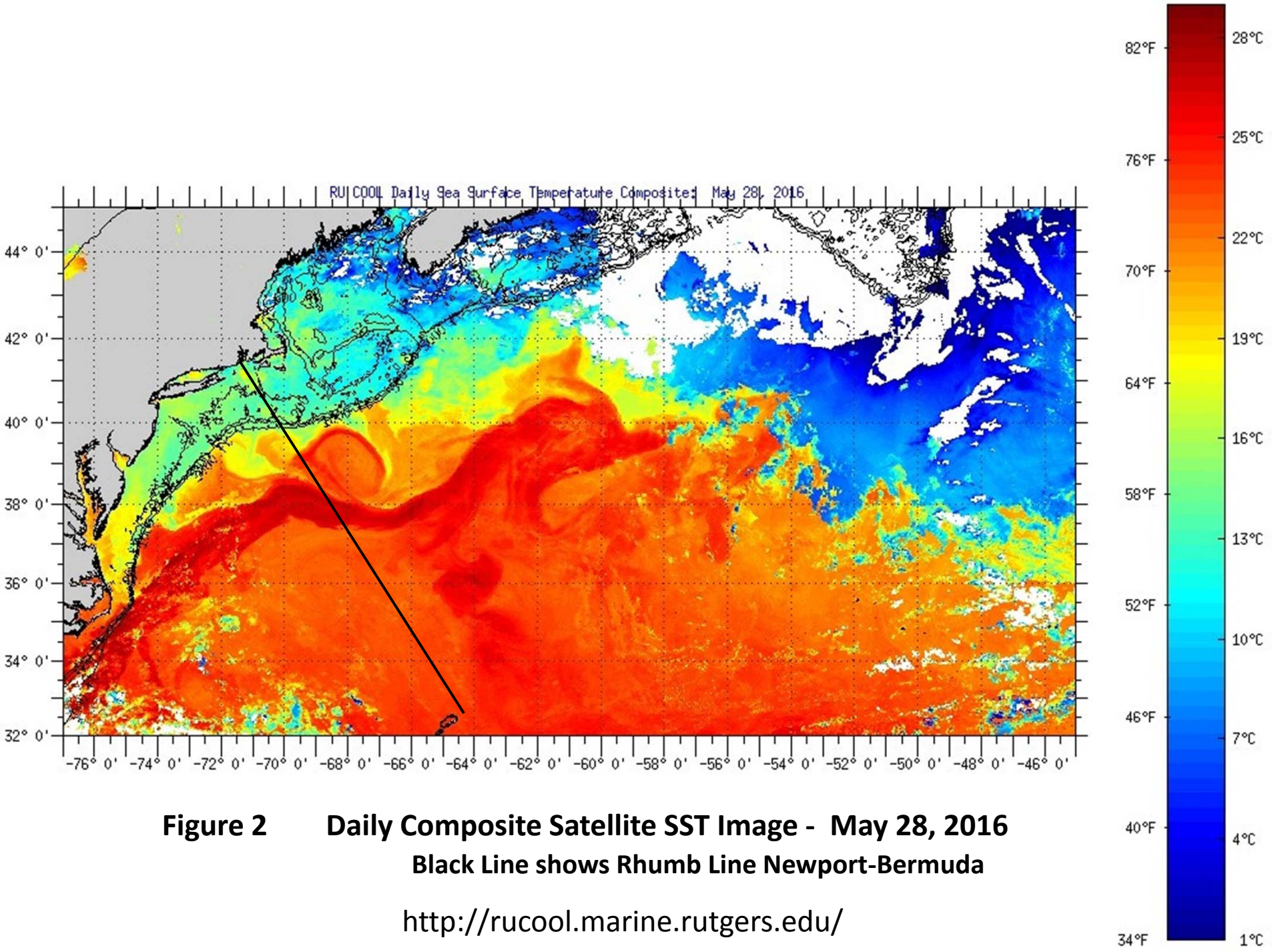

Figure 2 Daily Composite Satellite SST Image - May 28, 2016

Black Line shows Rhumb Line Newport-Bermuda

http://rucool.marine.rutgers.edu/

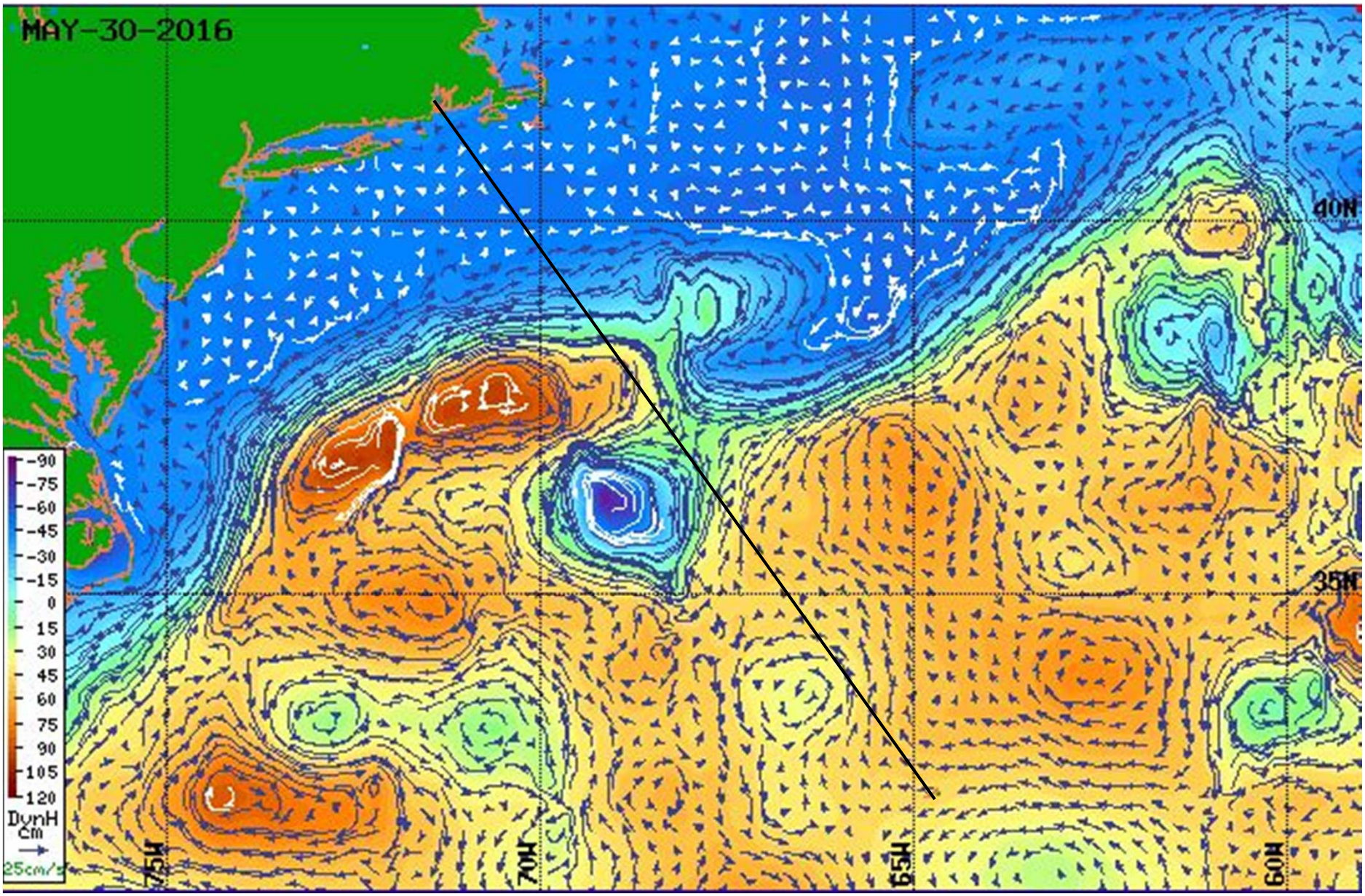

Figure 3 Satellite Altimetry Derived Surface Currents- NW Atlantic Region- May 30, 2016

Black Line shows Rhumb Line Newport-Bermuda

http://www.aoml.noaa.gov/

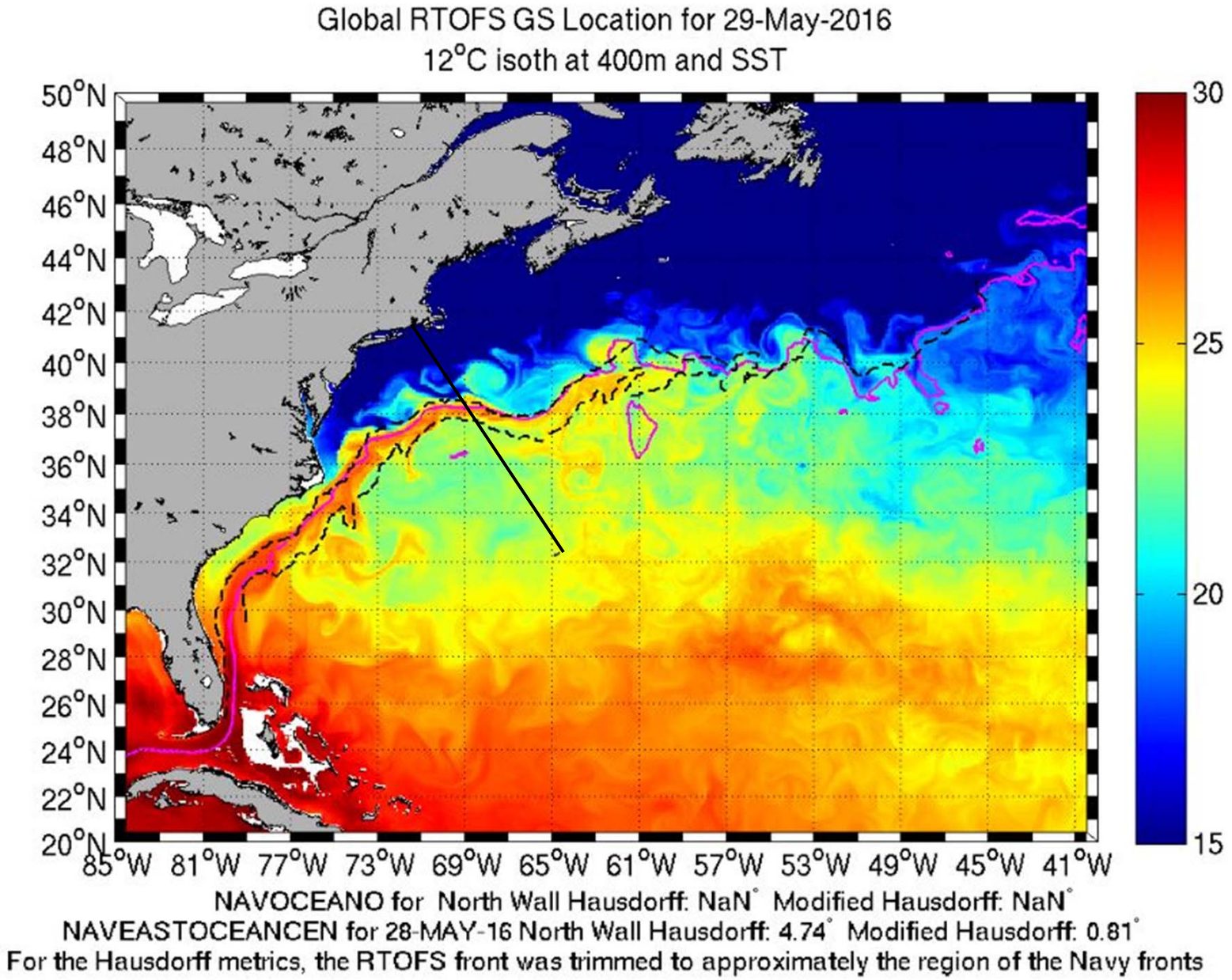

Figure 4 Northwest Atlantic Sea Surface Temperatures from RTOFS Model May 29, 2016

http://polar.ncep.noaa.gov/global/monitor/

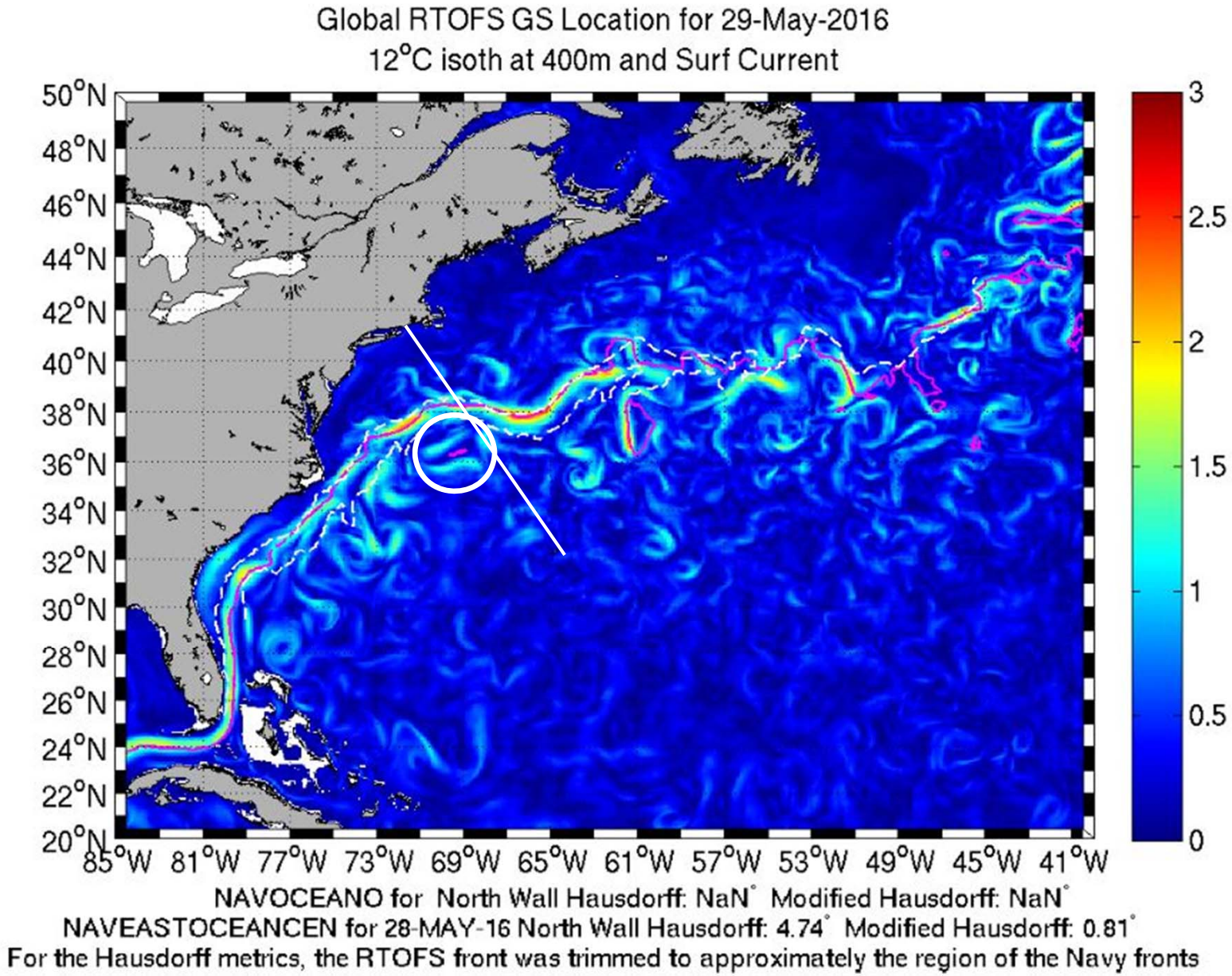

Figure 5 Northwest Atlantic Surface Currents from RTOFS Model May 29, 2016

http://polar.ncep.noaa.gov/global/monitor/