The Gulf Stream Near The Rhumb Line New England to Bermuda May 8, 2023
An Analysis of Conditions

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For those studying Gulf Stream characteristics in anticipation of racing to Bermuda the past few months have provided graphic illustration of the value of starting study early. Clouds have limited direct satellite observations for most of the time and when viewed the meandering Stream didn't seem to behave in any predictable manner differing substantially in evolution from previous years. These factors promise to complicate strategic decisions for the upcoming races.

In March the main body of the Stream crossed the rhumb line from the southwest to the northeast at a point approximately 250nm from Newport (Fig. 1). A prominent meander crest was positioned to the west of the rhumb line. Over the next month the crossing progressively rotated clockwise and by April 14th (Fig. 2) proceeded from the northwest to the southeast as the meander crest migrated to the northeast. A prominent warm core ring (diameter ~ 90nm) was positioned near 39^{o} 30'N 69^{o} W . The northeast migration of the meander was consistent with previous historical observations (see Bohlen – Gulf Stream: Structure and Strategy on race websites) but differed substantially from what had been observed in recent years when the forward progress of meanders formed to the east of Cape Hatteras slowed or stalled followed by marked deepening of the meander often leading to the formation of rings. In contrast, the sinuous form of the meander first observed in March progressively decayed as the flow appeared to "relax" resulting in a near linear northern edge of the Gulf stream by early May (Fig.3). This relaxation is clearly shown in the four day composite images (Figs. 4,5 and 6) with the linear form of the main body of the Stream extending well to the east of the rhumb line. The cause or causes of the aberrant behavior of the Gulf Stream meanders is likely due to changes in the strength of the Stream to the south of Cape Hatteras much in the manner of a flow from a hose controlling the form of the discharge. An exact relationship is yet to be established and may well prove elusive. For the moment the best the small boat navigator can do is to remain sensitive to the possibility of this range in behavior, carefully monitor meander shape and form using a variety of data, and build the potential for alternative scenarios into optimum routing.

One of the primary sources of data that I favor is NOAA's altimetry based model of currents (https://cwcaribbean.aoml.noaa.gov/CURRENTS/index.html). This model makes use of radar not affected by clouds and provides relatively detailed indications of the structure of the main body of the Stream as well as associated warm and cold core rings through the Sargasso Sea to Bermuda. It has proven to be a very useful planning and tactical tool.

In March the altimetry model provided clear indication of the meandering form of the Stream. An evident counter clockwise rotating cold core ring centered near 37° N 68° W favored an optimum route to Bermuda well to the west of the rhumb line. This westerly preference continued for nearly the entire route to Bermuda due to evident north going currents along the rhumb line south of 35° N.

By mid April flow structure had changed substantially as the meander moved to the east (Fig.8). The cold core ring observed in March was now well to the west of the rhumb line centered near 36° N 69° W resulting in adverse (for boats enroute Bermuda) north going currents in a large area west of the rhumb line north of 35° N. Further south currents were generally weak to Bermuda. There was also a noticeable decrease in the amplitude of Stream meandering east of the rhumb line.

Coming to early May, the linearization observed in the satellite SST images is clear also in the altimetry based model although the model more clearly indicates that the meander crest remains in place, near the position observed in April, as does some substantial flow structure (Fig.9). A weak counter clockwise flow affects a portion of the rhumb line near 37° N with some stronger northeast going flow to the south. The cold core ring observed in April to the east of 65° W (Fig.8) has drifted west and is now west of 65° W and is likely to reach the rhumb line over the next month. It seems clear that despite the linear form of the northern limits of the Stream the internal flows continue to display a moderate degree of complexity. The altimetry based model provides the best way to assess and or accommodate this complexity.

Keeping in mind our limited understanding of the factors affecting meander shape and form it should come as no surprise that sometimes our numerical models of Gulf Stream flows might be less than accurate simulations of these conditions. A comparison of the Navy and NOAA models for early May (Fig. 10) provides an example of this. The Global Real Time Ocean Forecast System (RTOFS), the most popular model used in routing programs ,continues to show a substantial meander trough differing substantially from the Navy model. The possibility that this is an error must be kept in mind when evaluating optimum routing recommendations. We will be carefully considering all of these potential sources of error and what they mean to our strategic decisions over the next few weeks as the Race start times approach.

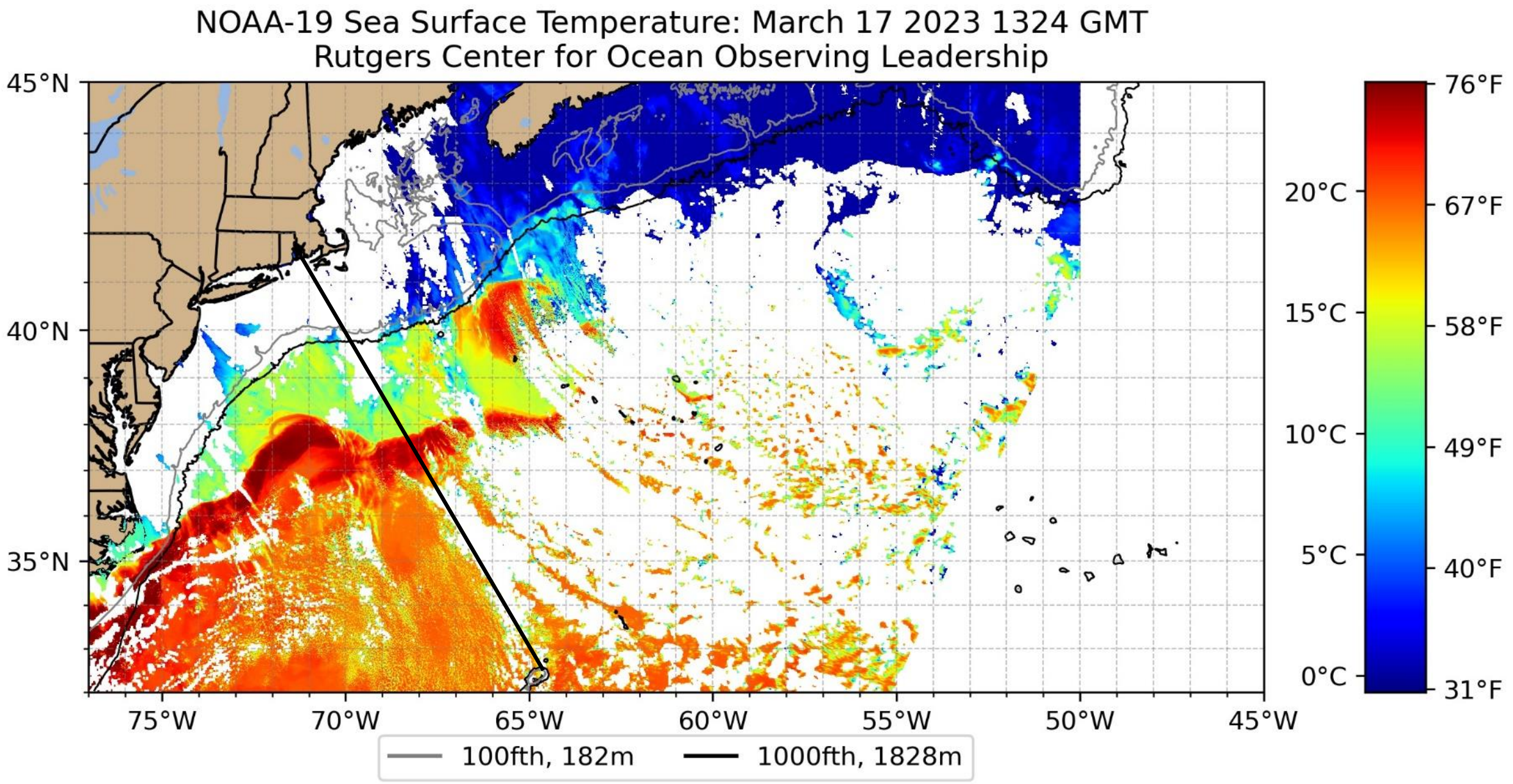

Figure 1 Satellite IR Image of Gulf Stream Surface Temperatures – March 17, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

Source: https://rucool.marine.Rutgers.edu

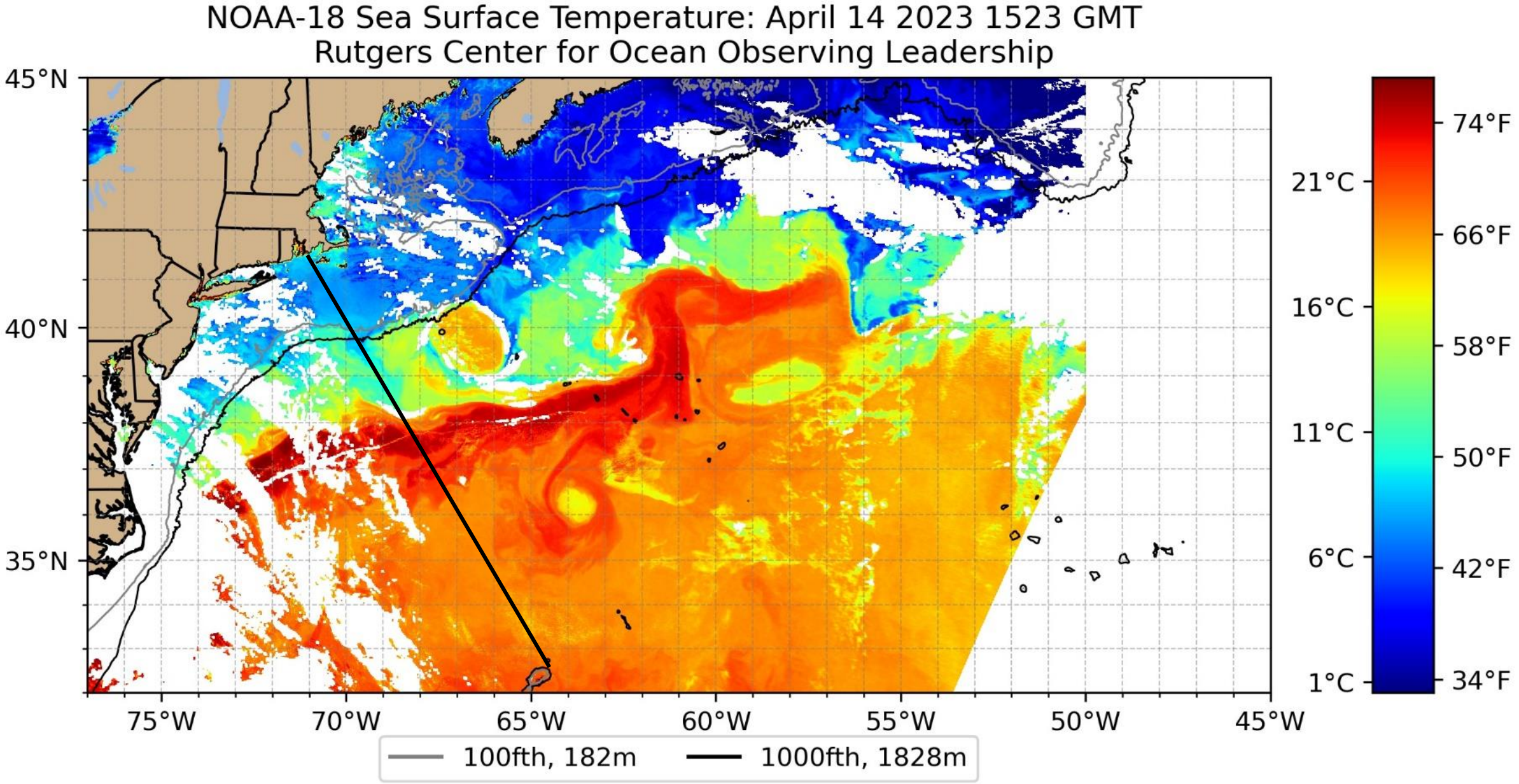

Figure 2 Satellite IR Image of Gulf Stream Surface Temperatures – April 14, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

Source: https://rucool.marine.Rutgers.edu

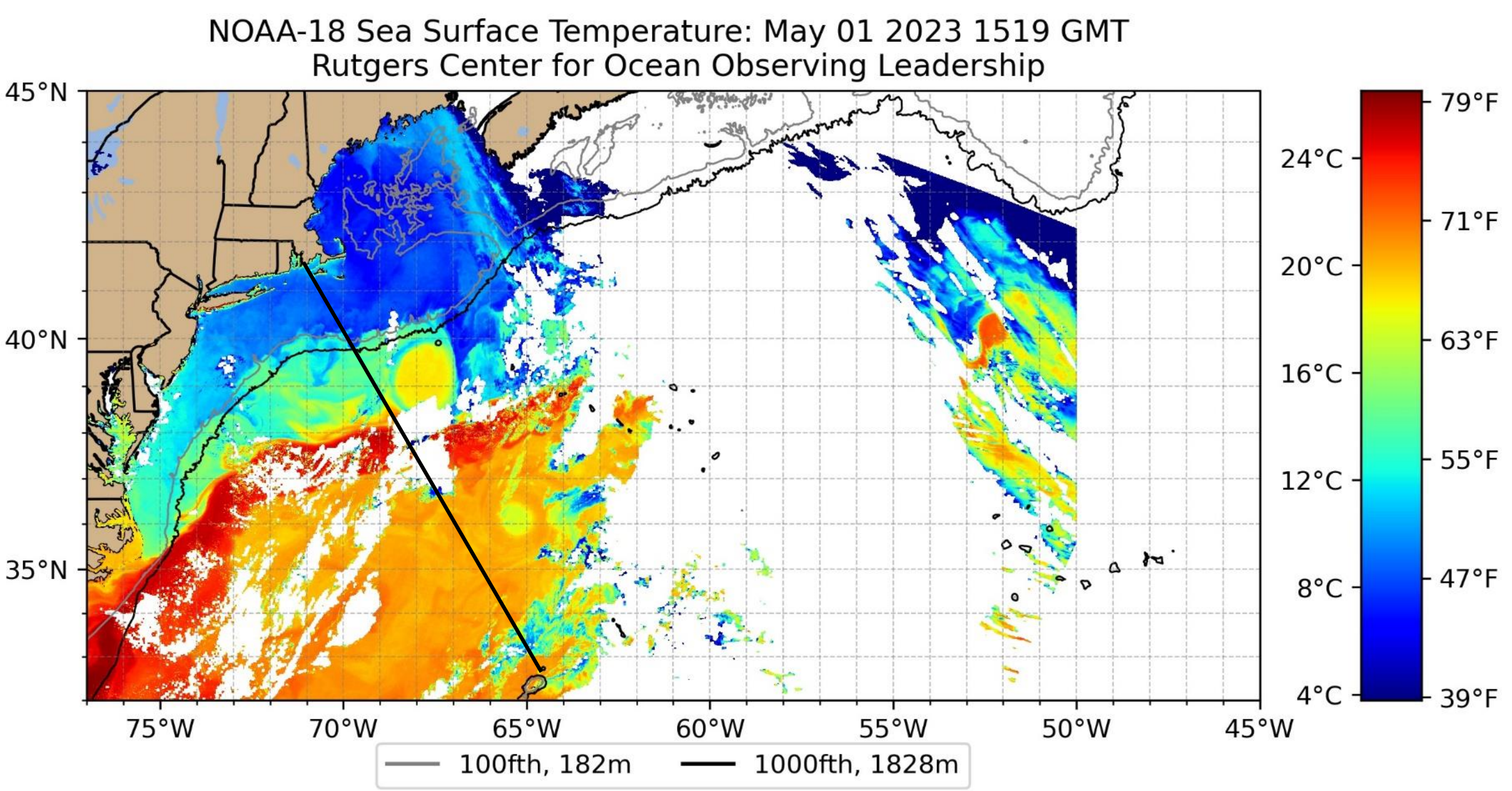

Figure 3 Satellite IR Image of Gulf Stream Surface Temperatures – May 1, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

Source: https://rucool.marine.Rutgers.edu

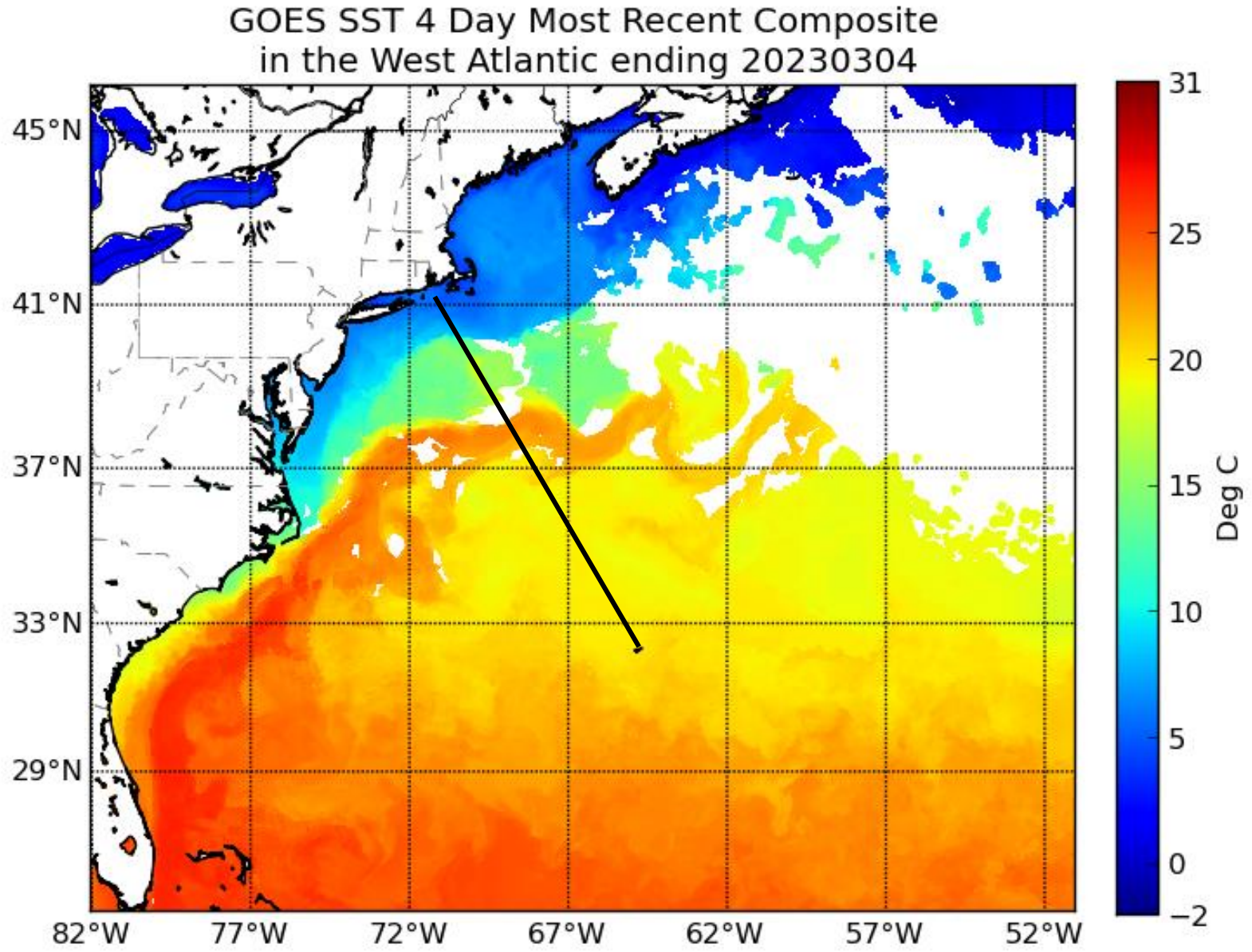

Figure 4 Four Day Composite – Satellite IR Image – Northwest Atlantic – March 4, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

Source: https://ocean.weather.gov/

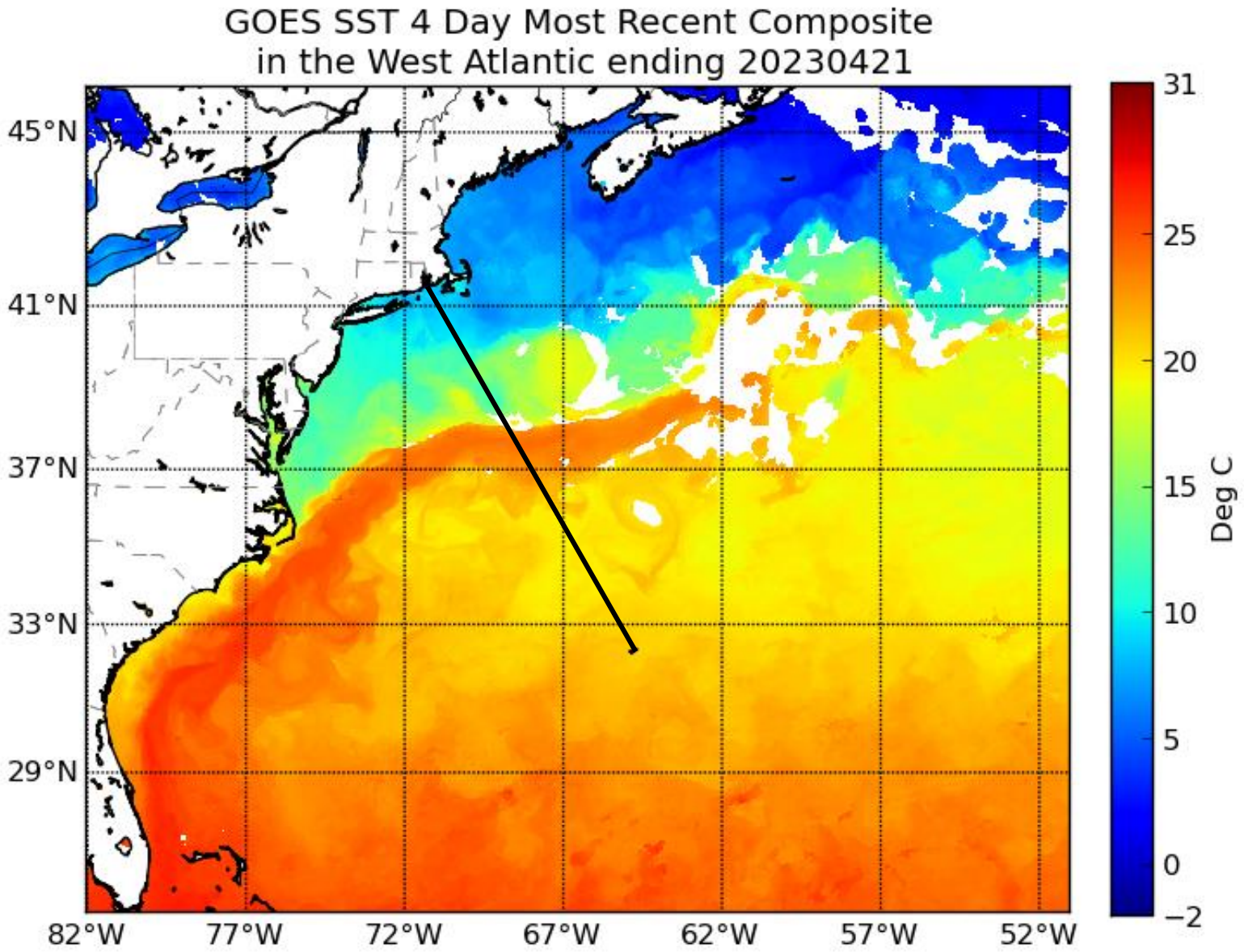

Figure 5 Four Day Composite – Satellite IR Image – Northwest Atlantic – April 21, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

Source: https://ocean.weather.gov/

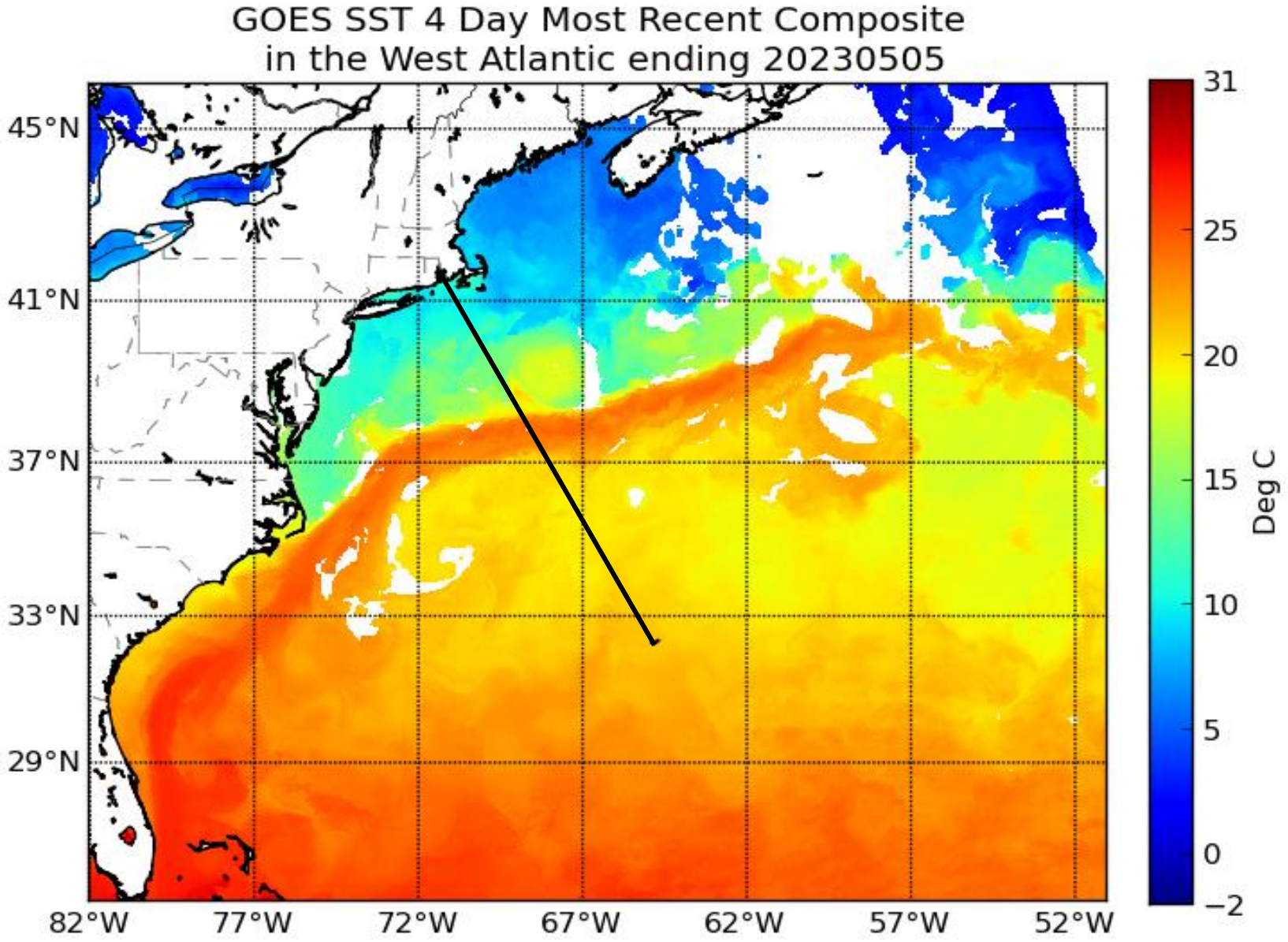

Figure 6 Four Day Composite – Satellite IR Image – Northwest Atlantic – May 5, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

Source: https://ocean.weather.gov/

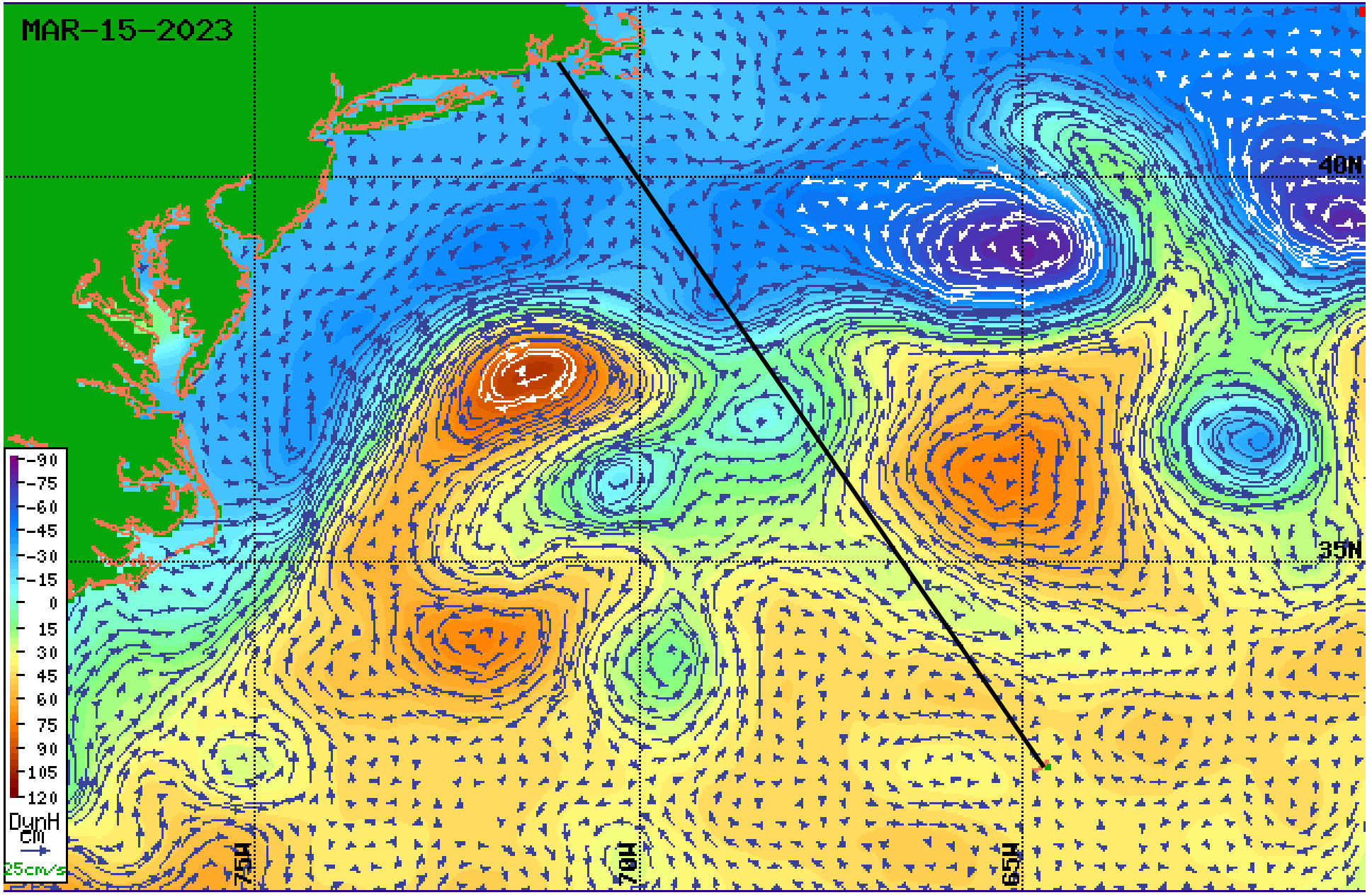

Figure 7 Altimetry Based Model of Northwest Atlantic Ocean Currents – March 15, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

https://cwcaribbean.aoml.noaa.gov/CURRENTS/index.html

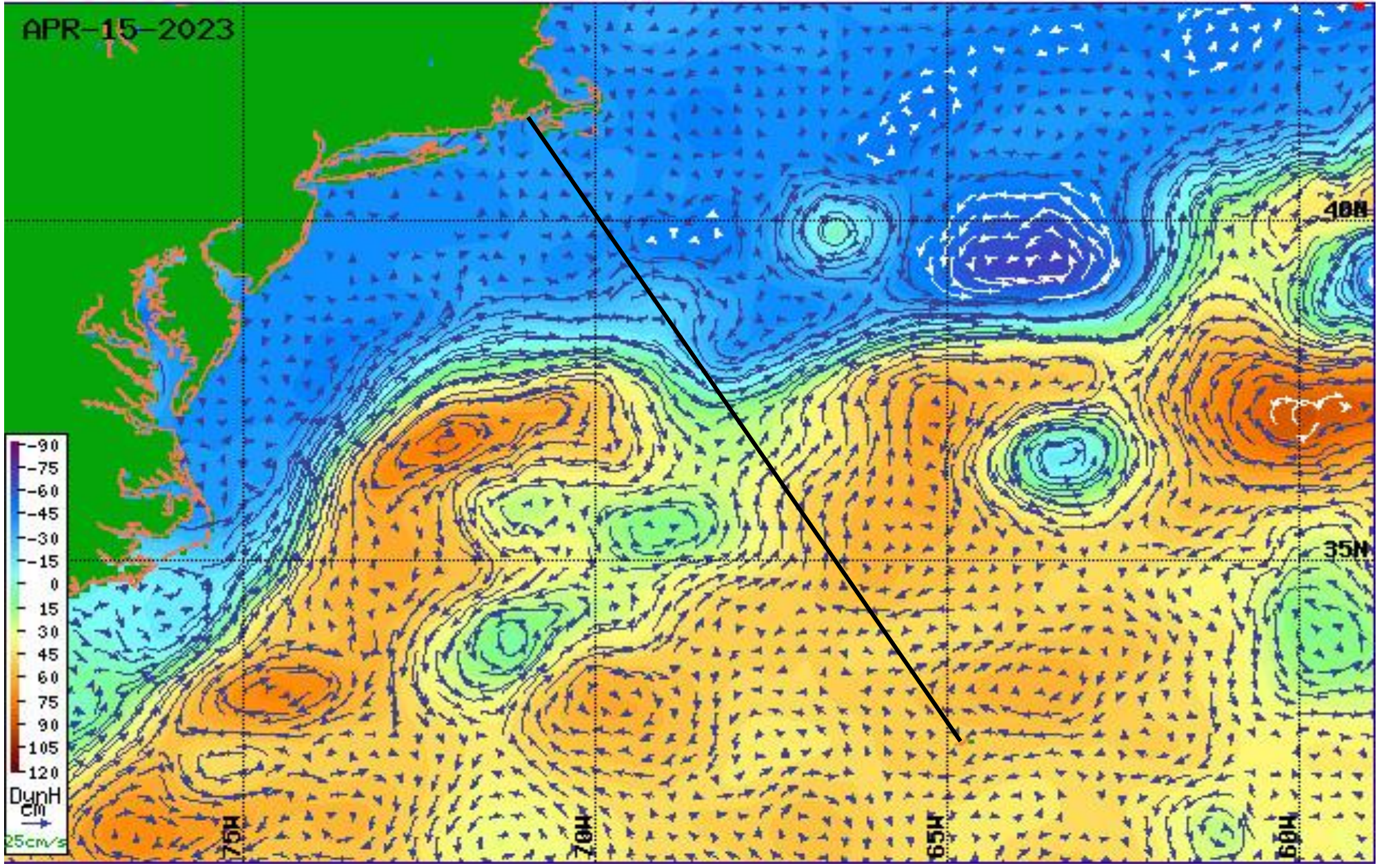

Figure 8 Altimetry Based Model of Northwest Atlantic Ocean Currents – April 15, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

https://cwcaribbean.aoml.noaa.gov/CURRENTS/index.html

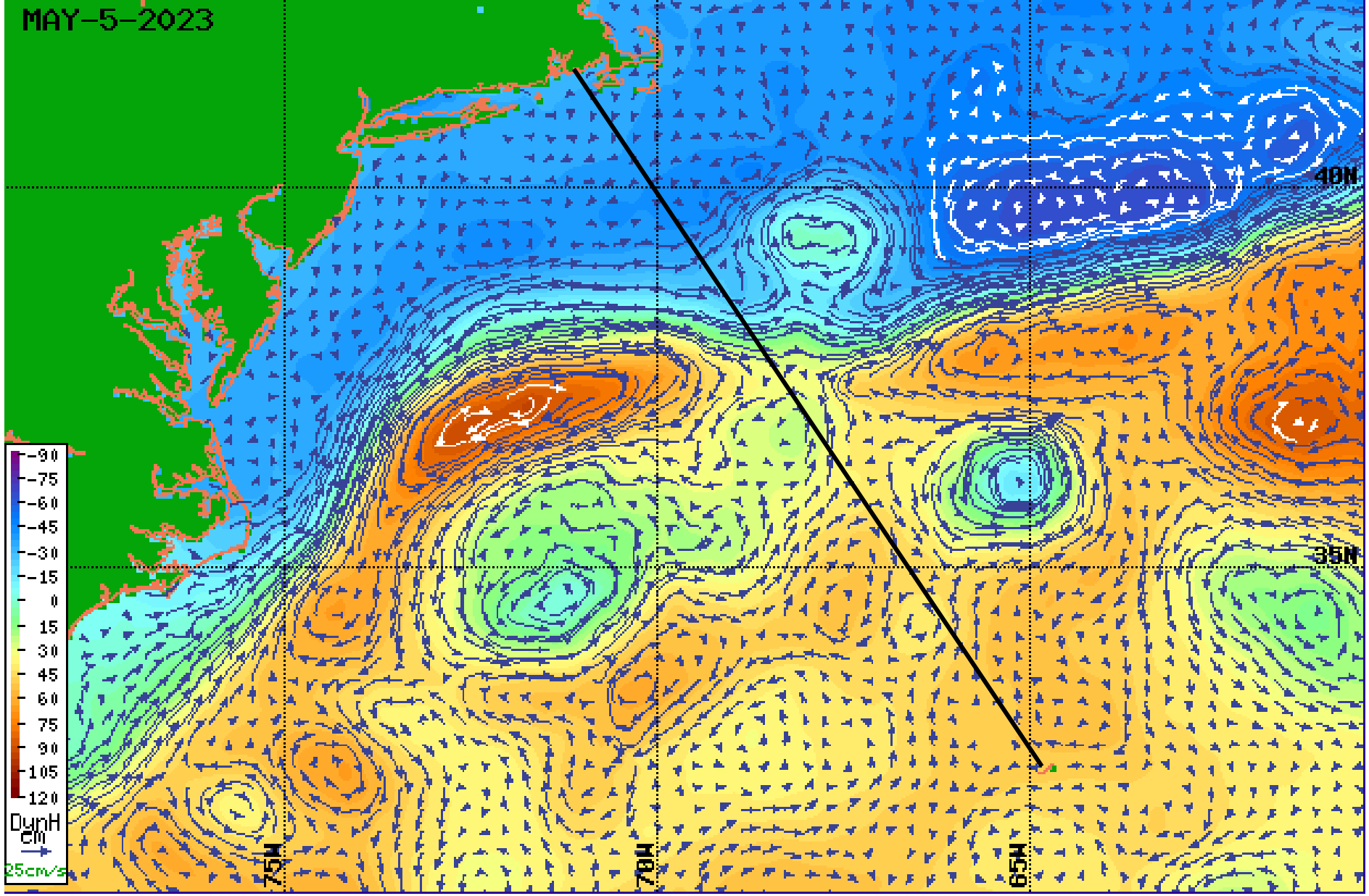

Figure 9 Altimetry Based Model of Northwest Atlantic Ocean Currents – May 5, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

https://cwcaribbean.aoml.noaa.gov/CURRENTS/index.html

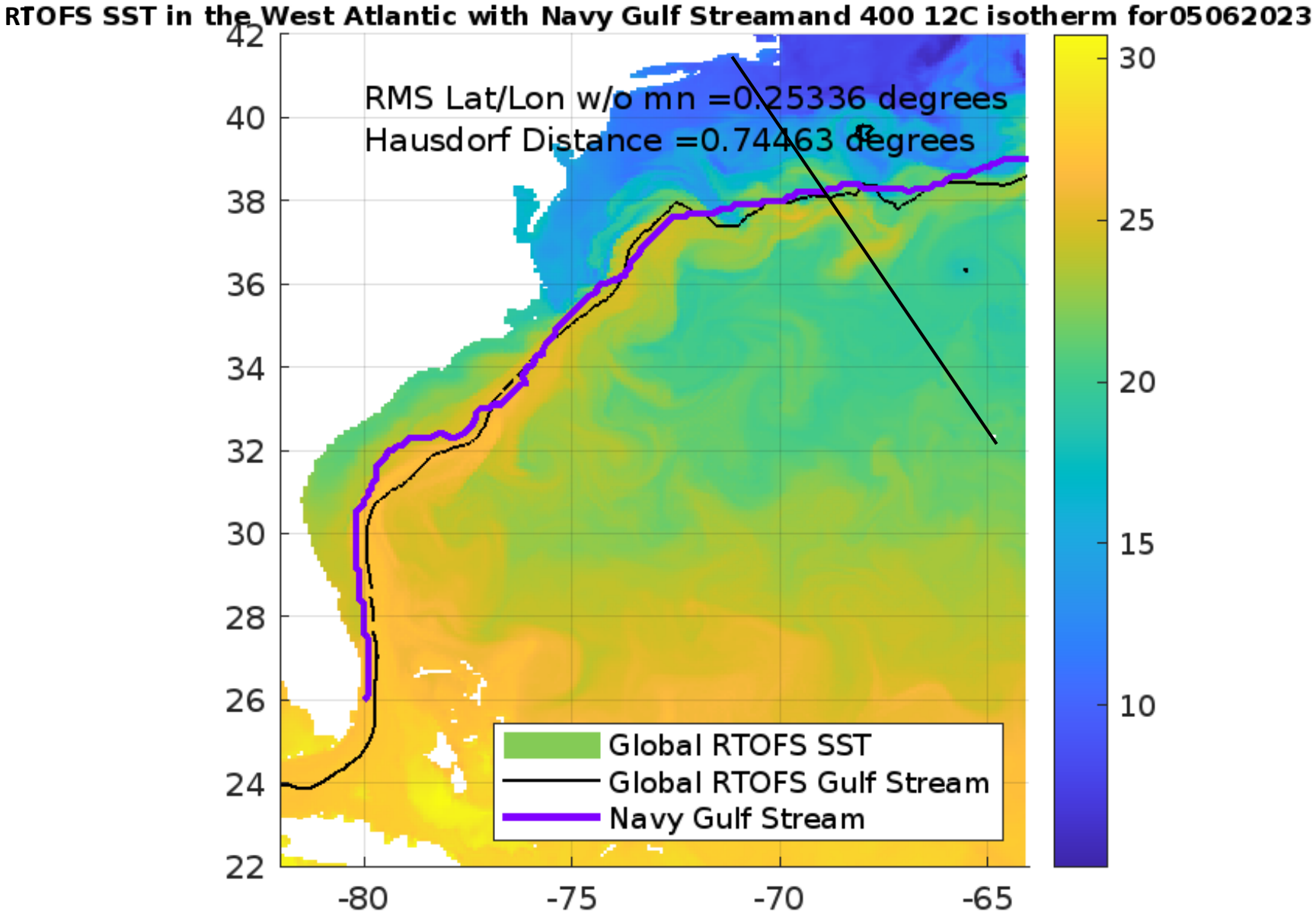

Figure 10 A comparison of Gulf Stream Model Results May 6, 2023

Black Line Indicates Rhumb Line Southern New England to Bermuda

https://ocean.weather.gov/sst/images/gulfstream/GScomp_GRtofs.png