The Gulf Stream Near the Rhumb Line Newport-Bermuda -- June 15, 2008
An Analysis of Conditions

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The Gulf Stream lobe observed on May 31, 2008 (see Note #2) has over the past two weeks been displaced west of the rhumb line as it progressively evolves into a discrete warm core ring centered near 38° 30' N 71° W (Fig. 1). The ring remains slightly elongated along its north-south axis and has what appears to be diminishing contact with the main body of the Stream along its southern margin. On the 14th of June its eastern limits were located approximately 25 nm to the west of the rhumb line. A clockwise flow proceeded to the south along this margin with maxima expected further to the west in the area of maximum thermal gradients. The northern limit of the ring was making contact with the continental margin near the 3000 ft water depth contour. This and the degree to which the ring remains in contact with the Stream will affect its future trajectory. To date, this ring has maintained close contact with the main body of the Stream. As noted, there is some indication in the latest sea surface temperature (SST) images that this is weakening (Fig. 1). Freedom from direct Stream influence could be accompanied by an increase in the expected westerly drift of the ring, away from the rhumb line.

The SST data show that the main body of the Gulf Stream crosses the rhumb line at nearly right angles near 38° N 68° 45' W (Fig.1). Flows at this point are proceeding to the east with a slight northerly component. Maxima appear to be located about 30 nm to the south of the initial point of contact with the warm water of the Stream (> 24-25° C ~ 78-79 °F). The Johns Hopkins 3 day composite ending on June 14 indicates that the northeasterly flows of the main body of the Stream affect approximately 90 nm of the rhumb line (Fig.2). Beyond this point the SST patterns favors south to southeasterly flows.

South of the main body of the Stream, the composite image (Fig. 2) shows a complex of thermal features including a patch of cold water near 35° N 70° W surrounded by warmer waters. Although this thermal pattern is characteristic of a counter-clockwise rotating cold core ring this feature appears to be the remnants of the clockwise rotating eddy produced by a splitting or bifurcation of the main body of the Stream as discussed in the last note (see Note #2). Evidence of this relationship is provided by the trajectory of the feature which since the 1st of June has been essentially due east or in opposition to the typical cold core ring trajectory. This implies that the feature is part of the main body of the Stream similar to a meander and that it is being carried to some extent fueled by the Stream. The eastern limits of the feature remain to the west of the rhumb line at present but it's likely that this distance will continue to decrease over the next few weeks.

The flows associated with the variety of thermal features evident in the satellite imagery

can be assessed using altimeter data. As previously discussed these data provide an indication of the sense and magnitude of the water column pressure gradients driving the flows, pressure gradients produced by changes in water column density caused by the observed differences in water temperature. Although the comparisons presented in the last two notes provide some reason for confidence that the altimeter based flow estimates are reasonably accurate it's important to realize that a model is used to develop these estimates and that as a result the flows observed by the small boat navigator might differ substantially from the plotted estimates. Careful and logged comparisons during the course of the race are advised. The resulting data compiled and passed to NOAA will represent the best way to improve the accuracy of the model while increasing navigator's confidence in the applicability of the model estimates. I'd hope that the results of some of these comparisons could be available for discussion at the Navigator's Forum on 26 June.

The altimeter data for the 15th of June (Fig.3) show first some amount of adverse current as one leaves Newport and proceeds south and east down the rhumb line to Bermuda. These flows are generally weak and consistent with the average westerly flow along the New England continental shelf. The influence of the warm core ring, which the altimeter shows as free standing and essentially clear of the Gulf Stream, is encountered at a point approximately 160 nm from Newport. Beyond this point flows, which previously had shown a dominance of northerly components, shift to the south. As expected the maxima are to be found 40+ nm to the west of the rhumb line. These flows persist showing some evident spatial variability until the northern limits of the main body of the Gulf Stream are encountered near 37^{o} 30' N 68^{o} 30' W.

The altimeter data show flows within the main body of the Gulf Stream, in a manner similar to that indicated by the SST data, crossing the rhumb line at nearly right angles. Flow maxima occur at a point approximately 30 nm southeast of the initial entry point with speeds in excess of 2-3 knots indicated. Actual maximum speeds can be expected to be greater than this. These northeasterly flows affect approximately 60 nm of the rhumb line before slowly shifting to the south under the influence of the clockwise rotating feature, discussed above, located to the west of the line. These southerly flows affect nearly 90 nm of the rhumb line persisting to 36^{o} N where the altimeter data show a counterclockwise rotating cold core ring located east of the rhumb line near 34^{o} 30' N 65^{o} 30' W. The region of maximum flow in this ring appears to be very nearly in contact with the rhumb line at present. This feature was evident in the altimeter data of 31 May and has become more organized over the past two weeks and has drifted slightly to the west. This trajectory should continue.

To the south of the cold core ring on to Bermuda the altimeter data show moderate west going currents similar in magnitude and direction to those observed in late May.

To summarize, the Gulf Stream and its associated features has over the past 15-16 days become more organized and presently displays a more nearly classic structure. Its present configuration displays favorable currents to Bermuda over the majority of the rhumb line. I'm sure that the implications of this relative to the upcoming race will be the subject of some discussion during the Skipper's Meeting scheduled for this coming Thursday.

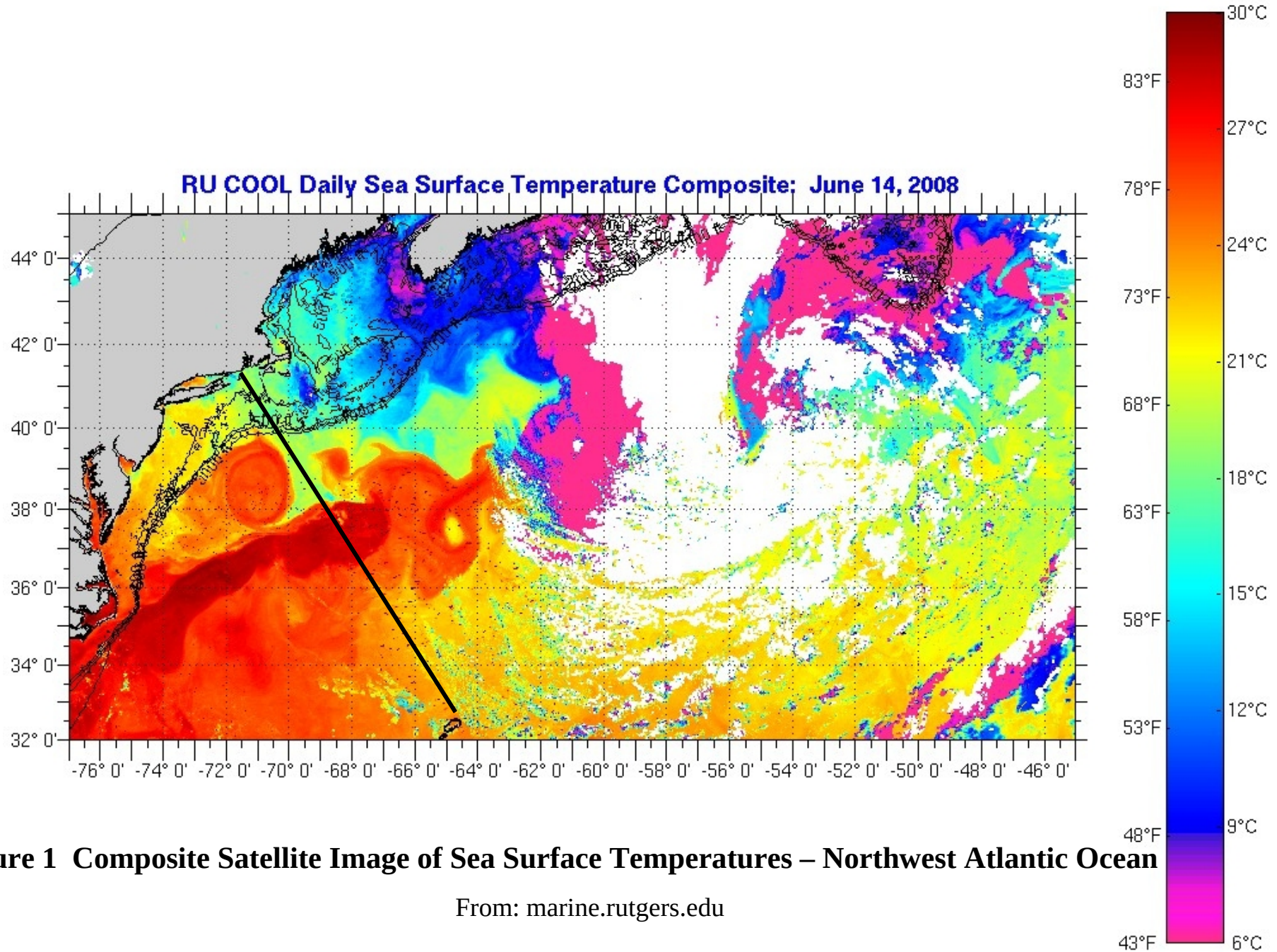

Figure 1 Composite Satellite Image of Sea Surface Temperatures – Northwest Atlantic Ocean

From: marine.rutgers.edu

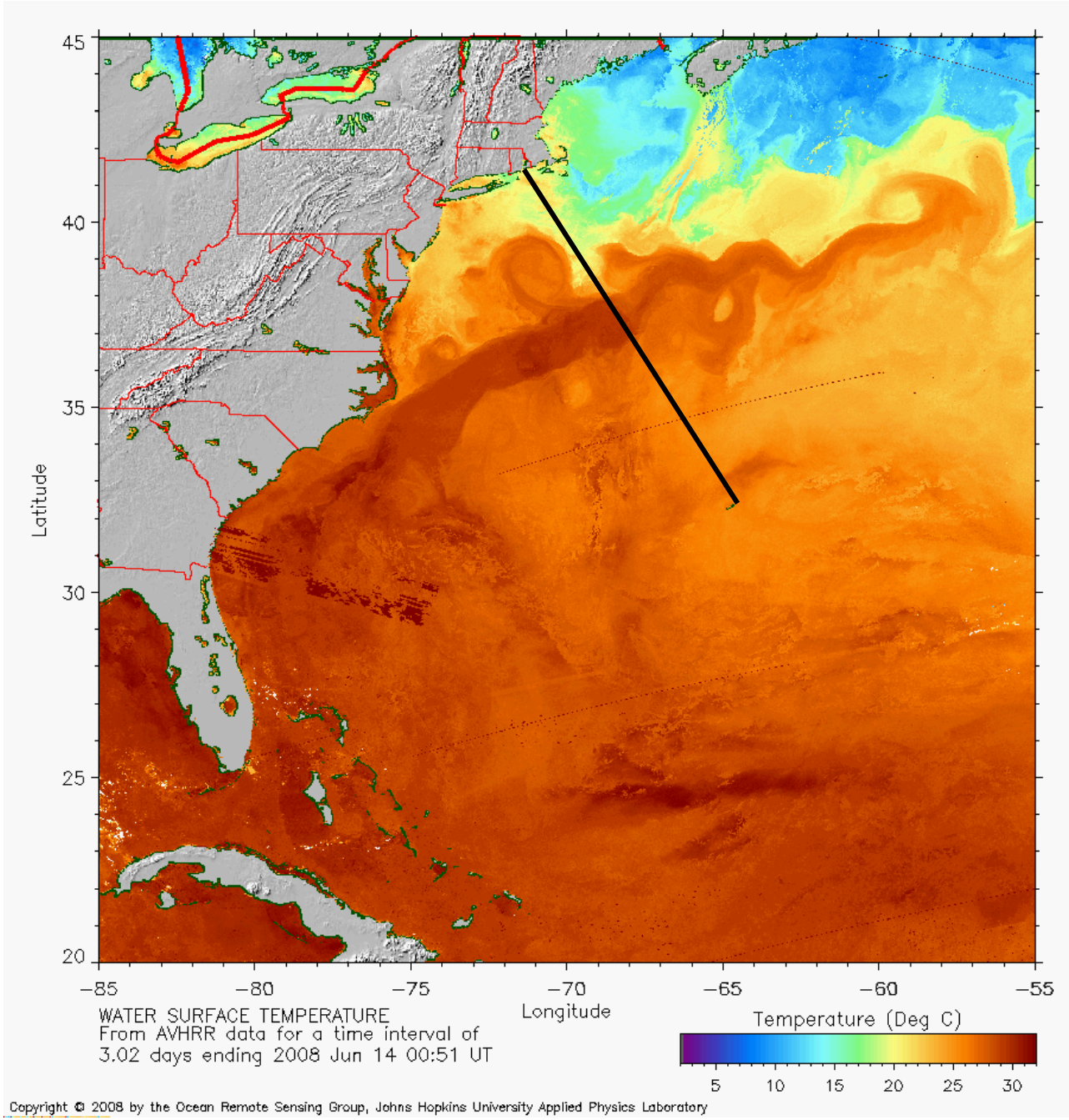

Figure 2 ~ Three Day Composite Satellite Image of Sea Surface Temperatures June 14, 2008

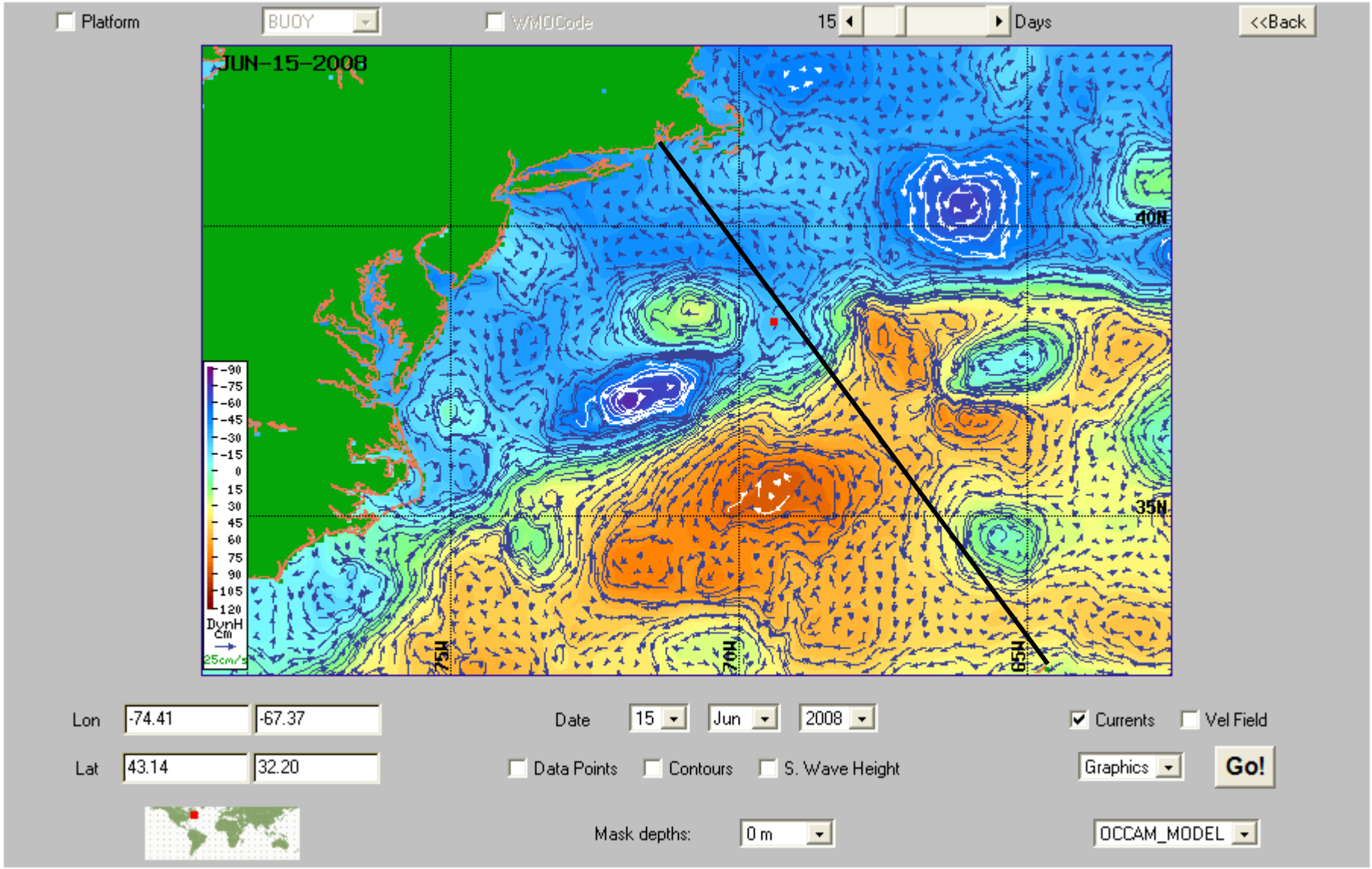

Figure 3 Current Speed and Directions in the vicinity of the Newport-Bermuda Rhumb Line Based on NOAA/AOML Altimeter Data June 15, 2008

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