The Gulf Stream Near the Rhumb Line Newport-Bermuda June 14, 2010
An Analysis of Conditions

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Over the past two weeks the evolution of the Gulf Stream in the vicinity of the Newport to Bermuda rhumb line discussed in my last note (see Bermudarace.com for previous notes) has continued producing some "very interesting" conditions that will clearly affect both the Race and the subsequent return transits. The structure of the main body of the Stream is of particular interest. The meandering pattern observed over the past few months has produced a progressively deepening feature to the west of the rhumb line that has forced warm waters north to the outer continental shelf near 39^{o} 30'N 70^{o} 30'W or a point approximately 90 nm from Newport (Fig.1). To the southeast of this point a prominent hook in the surface thermal pattern leads into an elongated southeast going limb of the Stream which very nearly parallels the rhumb line. This portion of the meandering pattern has the potential to affect over 200 nm of the rhumb line or nearly a third of the distance to Bermuda ! A comparison of the June 12th SST (sea surface temperature) image to that of the June 1 image in my previous Note indicates that this feature is proceeding to the east at approximately 4-6 nm/day. Continued, this trend will bring it in close contact with the rhumb line by the 18th or the start of the Race. The associated current field will produce flows proceeding from the northwest to the southeast or directly down the rhumb line towards Bermuda. Remember that the maximum currents are to be found in an area approximately 30 nm in from the northern edge (or in this case the northeastern edge) of the thermal feature marking the main body of the Stream in the region of the maximum temperature gradient.

The prominent hook at the top of the meander (Fig.1) was very nearly in contact with the rhumb line on June 12. Since this feature may affect the track from Newport to the area of current maxima it warrants close observation over the next few days. The instantaneous satellite image (Fig.1) suggests that the flow associated with this hook is not closed or circular in form and follows the outline of the feature from the southwest to northeast as the hook approaches the continental shelf and then turns to the south-southeast, parallel to the rhumb line for a distance of approximately 90nm before abruptly turning to the west and then northwest along the inner edge of the hook. This northwesterly flow continues for approximately 60nm before the flow again turns to the west and then southwest joining into the main limb of the meander. In this form, boats attempting to make for the current maxima in the vicinity of 38^{o}N 70^{o}W can avoid adverse currents by crossing near the apex of the hook. Again this portion of the meander is expected to proceed to the east at a rate similar to that of the main body of the Stream which may carry it across the rhumb line by the 18th or 19th leaving the apex just to the west of the rhumb line.

When discussing the hook like portion of the meander it's interesting to observe the

effect of compositing on this feature. Recall that cloud cover often requires the consolidation of a number of satellite images through an optical averaging process. This process often reduces spatial resolution and on occasion may introduce artifacts. A comparison of the single satellite pass or instantaneous image for June 12 at 0703 GMT (Fig.1) to the composite for the day (Fig.2) displays several of these effects including the apparent closure of the hook producing a feature similar in form to a cold core ring. If this feature was closed one might expect counterclockwise flows throughout and plan to avoid the area of the rhumb line intersecting the eastern limits of the feature. The single satellite pass image showing that the feature is open suggests favorable currents along the rhumb line. This apparent contradiction provides clear indication of the need for care in the use of composite images for strategic planning purposes and the advisability of using multiple sources of data in support of interpretations.

Neither of the satellite images (Fig.1 or Fig.2) provides clear indication of the presence of warm or cold core rings to the north or south of the main body of the Stream. Several of these features are however, shown in the altimetry based model results (Fig. 3). To the north of the main body of the Stream this model shows two counterclockwise rotating features one centered near 39^{o}N 72^{o}W and the other near 37^{o}N 68^{o} 30'W. Both were previously observed on the June 1 model plot (see GS Note #2). The latter is sited near the trough of the meander and has moved only slightly to the east since the 1st of the month. It appears to be trapped within the meander. The feature to the north has, as expected, moved slightly to the west away from the rhumb line. In its present position it should have minimal effect on the route to Bermuda. It's interesting to note that the altimetry based model provides little indication of ordered flow except for some rotational components apparently associated with the ring in the area of the "hook" evident in the SST images. This suggests that the altimetry sees much of the warm water north of 38^{o} N as an adjunct to the main body of the Stream with gradients in sea surface height producing relatively weak flows. The accuracy of this interpretation is however, difficult to assess and prudence favors careful consideration of routing across the hook. What is clear is that the stronger flows are to the south and slightly west of the "hook" region.

To the south of the main body of the Stream the altimetry based model shows a warm core clockwise rotating feature near the bottom of the meander and a developing cold core feature with counterclockwise flows just to the east of the rhumb line south of 35^{o} N (Fig.3). This latter feature is expected to drift to the west and should be on or across the rhumb line by the 18th. The northern warm core feature being in close contact with the Stream may remain essentially in place until the meander passes by the rhumb line. For the period of the Race these features should have relatively minor effect on the route to Bermuda for the majority of the fleet. This migration will however tend to affect flow patterns after the Race and should be monitored by returning crews.

See you Thursday !

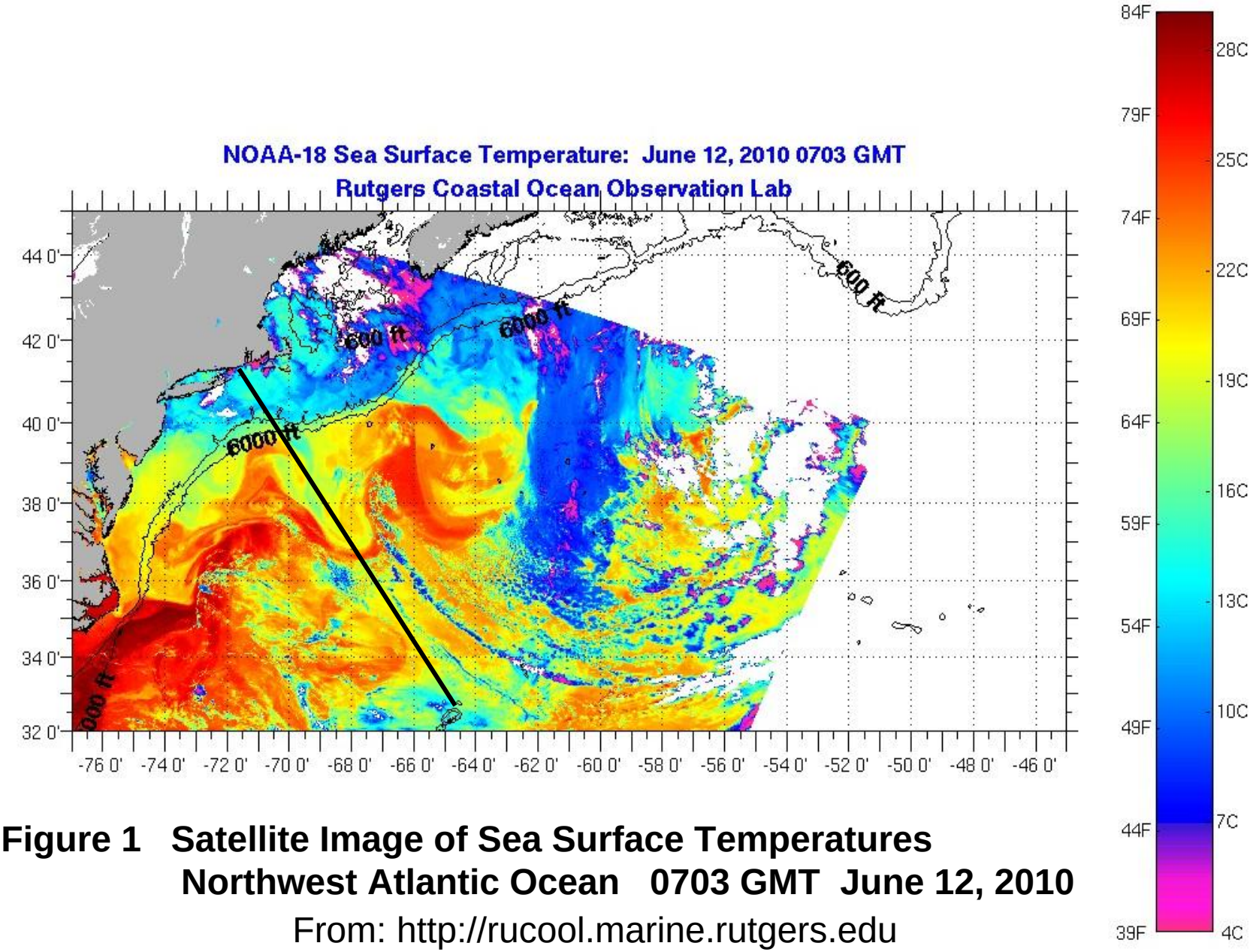

Figure 1 Satellite Image of Sea Surface Temperatures Northwest Atlantic Ocean 0703 GMT June 12, 2010

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

Dark Line indicates Newport-Bermuda Rhumb Line

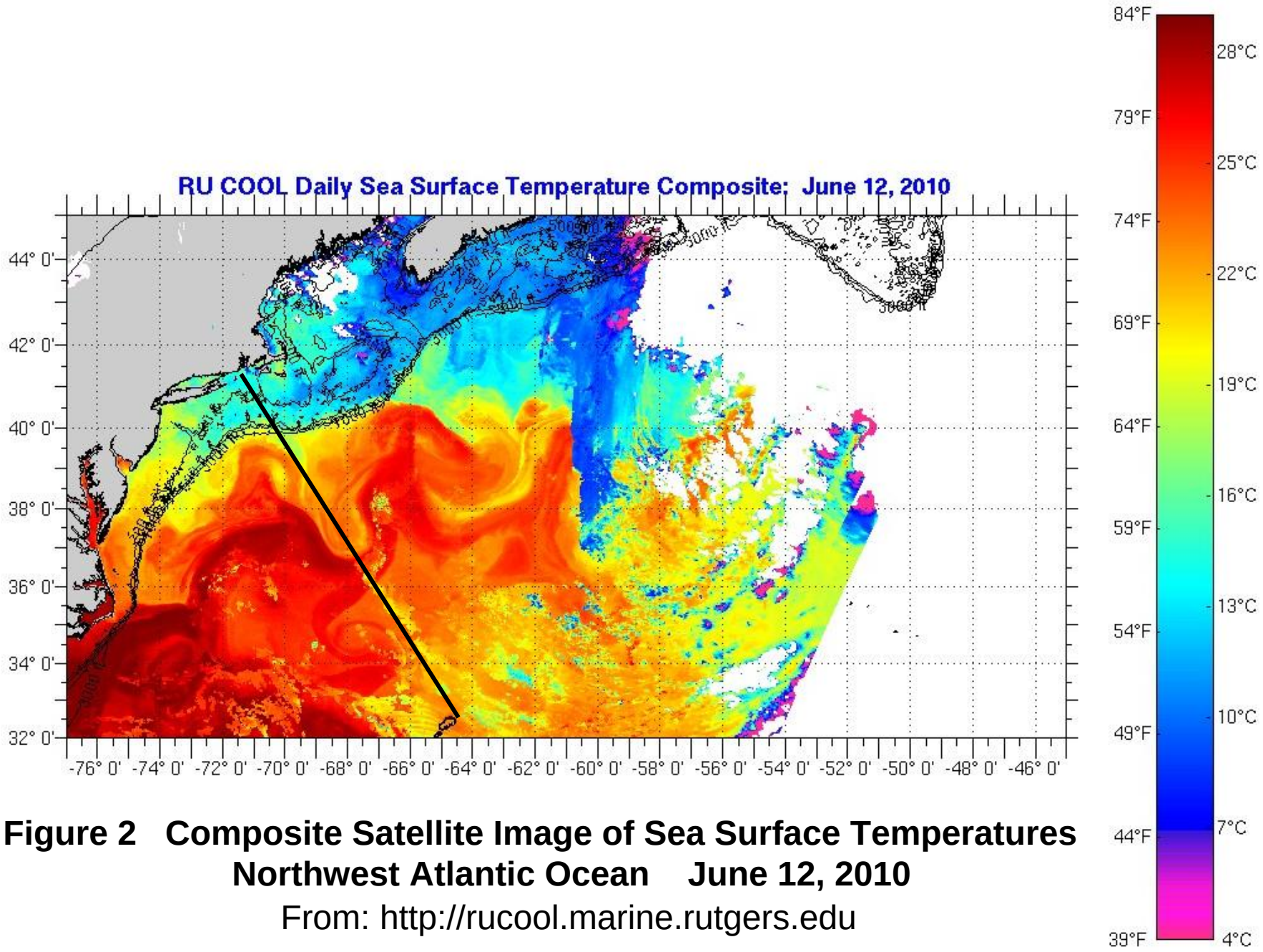

Figure 2 Composite Satellite Image of Sea Surface Temperatures Northwest Atlantic Ocean June 12, 2010

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

Dark Line indicates Newport-Bermuda Rhumb Line

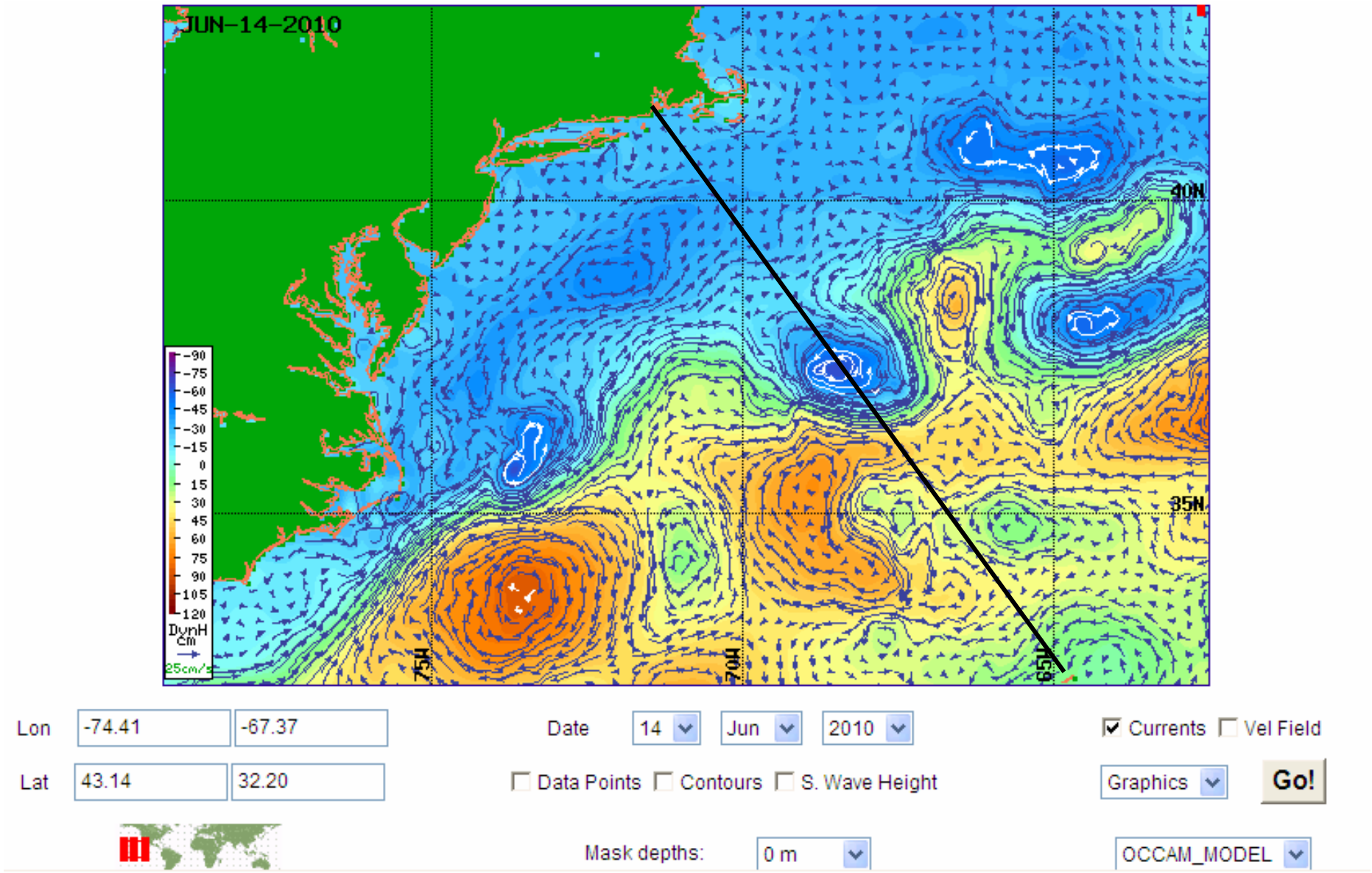

Figure 3 Current Speeds and Directions in the Vicinity of the Newport-Bermuda Rhumb Line Based on NOAA/AOML Altimetry Data

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

Dark Line indicates Newport-Bermuda Rhumb Line