



The Gulf Stream Near the Rhumb Line Newport-Bermuda May 30, 2018 An Analysis of Conditions

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Over the past three weeks the structure of the Gulf Stream in the vicinity of the Newport-Bermuda rhumb line remained dominated by a deep meander and a number of clockwise and counter clockwise rotating features to the south of the main body of the Stream. The north wall of the main body crossed the rhumb line at a distance of approximately 210nm from Newport near a crest of the meander (Fig. 1). Flows in the area proceeded from the northwest to the southeast nearly paralleling the rhumb line for a distance of approximately 70nm before turning to the east and northeast. A series of composite images of sea surface temperatures (SST) from the GOES 16 satellite showed the meander changing in form over the period but displaying essentially no easterly migration as sometimes called for in the textbooks. Examination of a sequence of selected four day composites from May 2nd through May 31st shows the meander which crosses the rhumb line progressing through a cycle of changing wave length and amplitude with minimal easterly drift (Figs 2-4). This sequence provides an indication of the characteristic time rate of change of the meander which is of particular value to a navigator during periods when cloud cover limits direct satellite observations of the Stream. The next question, of course, is how often these cycles occur. Does one immediately follow the other? That is best determined by continuing examination of the four day composites. These are a new product provided by the Ocean Prediction Center and with 2km resolution have the potential to significantly improve definition of the north wall location, structure and evolution. They warrant careful study. See https://ocean.weather.gov/Loops/ocean_guidance.php?model=GOES&area=MidAtl&plot=sstrec&day=0&loop=1

The cloud cover which has limited views of the Gulf Stream over the past five months continued through much of May forcing reliance on composite images which often lack the resolution to define flow features affecting the area from the inshore edge of the Stream, or north wall, to Bermuda. Under these conditions for analysis of this region I use the altimetry based model from NOAA (<http://www.aoml.noaa.gov>). As mentioned in Note 1 this model, relying on radar observations of sea surface height, is an all weather product and as such a valued adjunct to the composite satellite images. (For access you will need to install JAVA on your computer and Configure by entering the NOAA website into the Program's Exceptions List under the Security tab.) Comparing the composite SST satellite image of 25 May (Fig.1) to the model result published on 27 May (Fig.5) (a two day delay for data processing) shows the core of the Gulf Stream to be located approximately 30nm to the west of the sharp thermal

boundary forming the north wall . The model also shows a region of complex flow near the trough of the meander where the average flow turns to the east. There may even be a zone of adverse north going flow to the west of the rhumb line along 67° W (Fig.5). Speeds of less than 1kt may be encountered in this area.

Proceeding southeast along the rhumb line beyond the influence of the meander the model shows a clockwise rotating feature centered near 35° 30' N 67° W affecting an area 60nm to the west of the rhumb line and producing maximum speeds of approximately 3kts. This feature has developed over the past two weeks and may be the result of interactions with the evident counterclockwise (cold core) ring along 65° W. This ring was present in early May and has moved nearly 60 miles to the south over the past three weeks. We will continue to carefully monitor its progress and influence as Race time approaches.

Further to the southeast towards Bermuda, the altimetry based model shows another clockwise rotating feature centered near 33° 45' N 64° 45'W. This feature was present in the model result of May 6 discussed in Note 1. Over the past three weeks it has drifted only slightly to the west. Again maximum speeds could approach 3kts to the northwest in the region of the rhumb line. Its proximity to Bermuda in combination with its size and drift makes it likely to influence the final approach to the island and the associated optimum routing.

In addition to the altimetry based model it's useful to examine the results of the NOAA numerical model of northwest Atlantic circulation depicted in the Global Real Time Ocean Forecast System (RTOFS) at <http://polar.ncep.noaa/global/monitor/> . The results of this model are available in digital format so are often used in routing programs. Comparison of the RTOFS results to the altimetry based model as well as the direct satellite observations of SST provides a sound basis for optimum routing. The modeled SST (Fig.6) pattern is reasonably similar to that shown in both the composite satellite image (Fig.1) and the altimetry based model results (Fig.5). The satellite image shows the meander to be a bit more abrupt or peaked than the RTOFS result which affects the flow trajectory once the Stream is entered and to some extent the point at which the rhumb line intersects the north wall of the Stream. The rhumb line entry point for a boat enroute Newport to Bermuda looks to be approximately 30nm further southeast in the RTOFS depiction than that shown in the composite SST satellite image (compare Fig.1 to Fig.6). The current pattern provided by the RTOFS (Fig. 7) differs substantially from that shown by the altimetry based model (Fig.5) and provides only limited indication of coherent flows to the south of the main body of the Stream. This may be an artifact of the resolution of the printed images with the flows not shown in the image actually included in the digital file. This can only be determined by careful examination of the results provided by the routing program based on the RTOFS data.

All of these Stream factors and features will be carefully watched in combination with the developing weather patterns over the next two weeks.