DETECTION OF NORTH-WALL AND EDDIES IN THE GULF STREAM IN AVHRR SEA SURFACE TEMPERATURE USING CLUSTERING

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This paper addresses the issue of detecting the north wall of Gulf Stream. The study of Gulf Stream has a lot of significance, playing a major role in effecting the climate change, formation of cyclones, influencing the productivity of fishing areas etc. It is also a subject of interest as an alternative source of renewable energy. The most effective, efficient and fastest way of obtaining data for the study of this Gulf Stream is by remote sensing. There are various forms of remotely sensed data but the most widely used data for oceanographic study is the sea surface temperature data. Previously many oceanographic features were studied by using this SST data, there is one more set of data called the altimetry data which was also used to study some features of ocean. Here we are proposing the use of a novel approach in using both data sets (SST and altimetry) to detect the north wall of Gulf Stream. We are using the velocity data obtained from altimetry data as a reference to extract the north wall of Gulf Stream. The north wall of the Gulf Stream reveals very complex structures associated with frontal instabilities that lead to exchanges between the Gulf Stream and inshore waters.

The area of study is storm watch region of Gulf Stream - 80^o W to 45^{o}W, 30^{o}N to 55^{o}N. The fact that the maximum velocity line lies primarily within the Gulf Stream is used as the basis for using the *velocity line* as the base reference to detecting the north wall. The complete process of extracting the north wall is done in four steps. In the first step a *Fuzzy c- means clustering* algorithm is applied on the sea surface temperature data thereby dividing the SST data into different iso-temperature clusters. In the second step the border of the cluster to which the max velocity line belongs is determined. The velocity data is clustered using fuzzy C means clustering algorithm and the border of the cluster to which the max velocity line belongs is determined. From the borders extracted in the above mentioned two steps a single border is obtained by a merging process. A study for the optimal number of clusters to be considered for obtaining the maximum accuracy was determined to be seven for the SST data and four for the velocity data. The results we obtained by using the above method were encouraging. The detection of north wall was 80% accurate on more than 80% of images and the accuracy increased with decrease in could cover noise of the image. The black line in Figure 1 shows the extracted north wall from the discussed procedure.

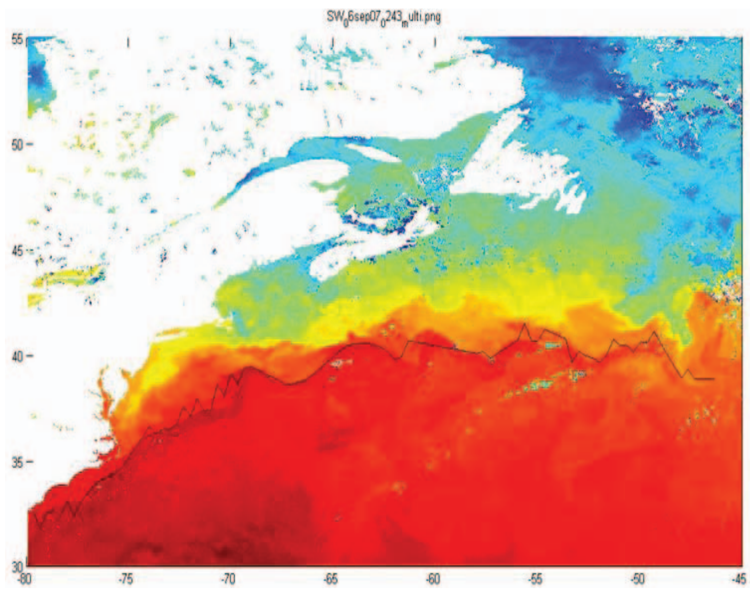

Figure 1- The black line in the above figure is the extracted north wall

The Gulf Stream generates many eddies along its flow. Previously finding these eddy in the data required applying a brute force shape analysis algorithm which consumes a lot time and computing power. The second contribution of this paper is an approach to locating mescoscale eddies that are generated by the Gulf Stream by observing the dips or large variations in the maximum velocity graph plotted along the lat and longitude axes. Now the shape analysis algorithm can be applied only at these dips thereby saving a large amount of time and computing power. Figure 2 shows is the maximum velocity plot over the velocity data and it shows dips in the maximum velocity plot each of which corresponds to an eddy. Figure 3 shows a close-up image of several such dips in the velocity line as well as corresponding eddies.

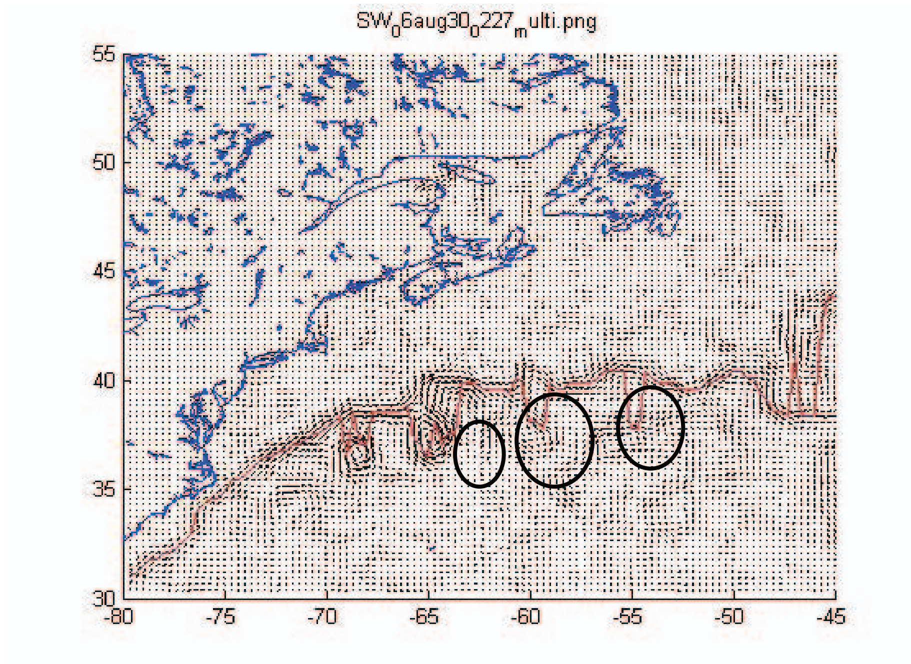

Figure 2 Eddies observed at dips in the max velocity curve

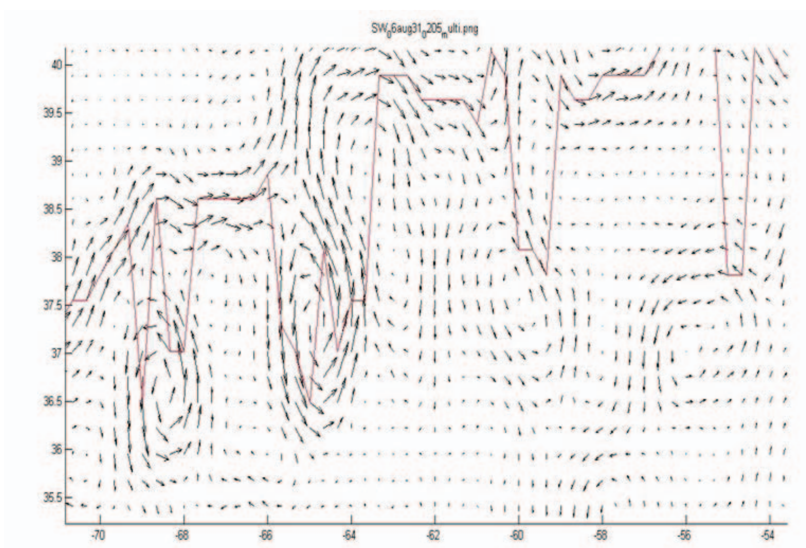

Figure 3 - A Close-up image with max velocity curve and velocity data

For future work we are exploring the use of vorticity data along with SST and velocity data sets to extract the north wall and eddy. A three dimensional clustering algorithm is being investigated.

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