METHODOLOGY FOR EDDIES RECOGNITION FROM SATELLITE IMAGES

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1. INTRODUCTION

The development of techniques for rapid and conclusive characterization of mesoscale oceanographic features has been a constant search by professionals who needs fast and accurate results. The visual analysis of images obtained by remote sensors has been used to determinate oceanographic features for some time. However the visual evaluations are tiring and can lead to inconsistencies, especially when you need to interpret large volumes of data. The aim of this work is the use of specialist tools to facilitate the interpretation of data and recognize eddies semi-automatically, allowing greater agility and decreases on ratings subject to human error.

Sea Surface Temperature data (SST) measured via remote sensing with its high spatial and temporal resolution and high capacity to form patterns on the surface are the most suitable for the identification of dynamic processes such as currents, upwelling, eddies and meanders. In this study we used data from SST series of GOES satellites for the years 2003 to 2008. The study area is the south-eastern Brazil between 20°S-26°S and 49°W-35°W.

2. METHODOLOGY

For semi-automatic eddies identification in SST images, has developed a morphological classifier based on a structural element in a circular shape that covers the target area in search of eddies candidates based on maximum similarity. During the process of developing the classifier, there is a by-product is the estimation and analysis of the dimensions and statistics of eddies in the region of study, based on meteorological analysis, used to identify the main eddies characteristics, such as geographic location typical, diameter and thermal gradient, and define the search area of classifier. The pre-processing is a fuzzy clustering to define the eddies search regions, which are the clusters edges. The classifier is applied as follows.

1) The fuzzy c-means (FCM) algorithm is used to clustering SST images;
2) The clusters gradient is calculated to obtain clusters edges. This is possible because each cluster has the same identification number. Gradients to zero (within the clusters) is assigned NaN value and non-null (edge) value 1;
3) It creates a square matrix of odd order with NaN values. Assign values 1 to square matrix positions that respect the general equation of the circle. Therefore, it creates the structuring element is a square matrix with values 1 that defines a circle. Este círculo possui uma espessura de três pixels, pois os vórtices reais apenas se aproximam de círculos. This circle has a thickness of three pixels, since the real eddies seems to be a circles. The diameter of the structuring element is variable and set based on the eddies climatology;
4) Starts the search process in the edges clusters obtained in step 2. This search is done with the structuring element covering the entire target area. It is considered as a likely center of the eddy coordinates of the

pixel matrix gradient that best fits the structuring element that will be with its center in the same pixel. The diameter of the eddy is considered the same of the structuring element;

5) At the end of the scan, the structures identified at least 40% of matching points in the structuring element, at least 20% in two adjacent quadrants, are candidates for vortices;
6) For each candidate compute the zonal gradient of SST field along the latitude passing through the center of the eddy. As the peak gradient must occur at the edges of the eddy, are eliminated eddies candidates whose distances between the peaks of gradient are greater than 20% of the diameter;
7) For remaining eddies candidates, plots the zonal SST gradient in latitude for the center of the eddy. And also plots the candidate's image eddy with SST values. Thus an expert selects the true eddies.

3. RESULTS AND CONCLUSIONS

It's been developed a efficient eddies classifier with little intervention from an expert, reducing the visual analysis of features and enabling the analysis of a large quantity of images in a short time. All semicircular eddies were identified. The image quality has great influences in the clustering and thus permits the identification of false eddies in the presence of noise. In clustering with 3-partitions (Figure 1), the identification capability is 100%. The SST zonal gradient and SST's original image in the region of probable eddies (Figures 4 to 7) allow the elimination of false eddies by people with minimal training.

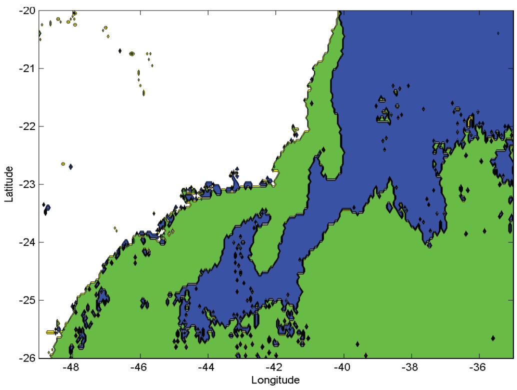

Figure 1: SST field clustering

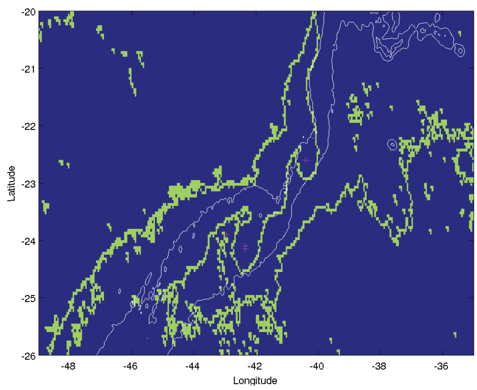

Figure 2: Clustering gradient

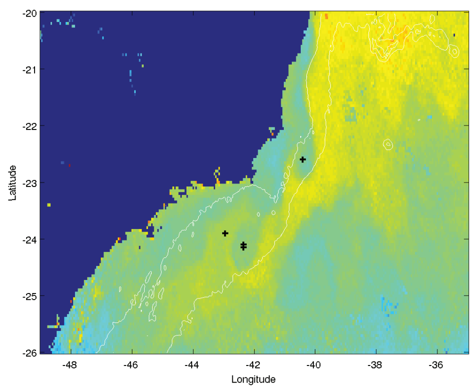

Figure 3: SST eddies candidates image

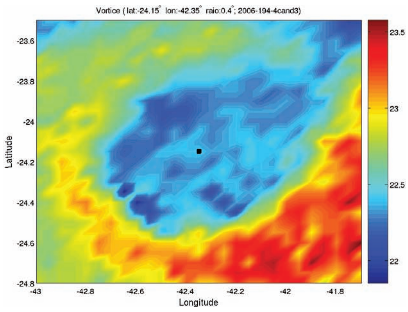

Figure 4: eddy

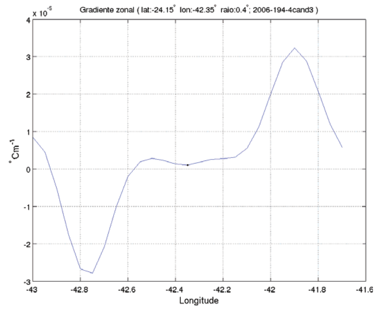

Figure 5: SST zonal gradient in eddy central latitude of figure 4

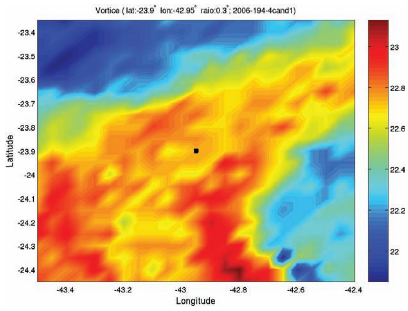

Figure 6: false eddy

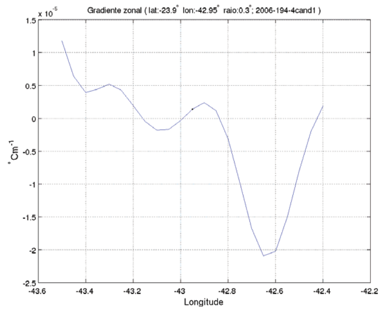

Figure 7: zonal gradient in eddy central latitude of figure 6

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