DYNAMIC THRESHOLD CLOUD DETECTION ALGORITHM IMPROVEMENT FOR AVHRR AND SEVIRI IMAGES

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1. INTRODUCTION

The aim of this work is to present a simple and fast automatic cloud detection algorithm for Advanced Very High Resolution Radiometer (AVHRR) and Spinning Enhanced Visible and Infrared Imager (SEVIRI) satellite images. The algorithm was developed by the Satellite Receiving Station at Prato Campus (University of Florence), where AVHRR and SEVIRI data have been directly received since 1997. The algorithm is designed to meet the need for real-time operational processing of land and sea products, such as vegetation indexes and regional land/sea surface temperature maps (i.e. Italy). It is developed as simple and fast processing which does not need to use ancillary data.

The algorithm is tested for AVHRR and SEVIRI images directly received at the Station which are characterized by different percentages of cloudy pixels. Algorithm results are compared with control cloud masks, which are created manually by a visual inspection of the image to be cloud screened.

2. DESCRIPTION OF WORK

The developed algorithm, among those published in literature [1] [2] [3] [4] [6] [7], is an improvement of the dynamic threshold cloud-masking (DTCM) algorithm presented by [2]. The DTCM algorithm presented in this paper was designed as a fast and straightforward scheme for regionally tested cloud masking over both sea and land. Processing was carried out during both the day and night time.

In the visible wavelengths, during the daytime, reflectance values of cloudy pixels are higher than those of land or sea pixels in a clear sky. This is true if snowy or icy areas are not considered. These features allow a possible identification of cloudy pixels by using a threshold that equals the lowest reflectance value of clouds.

Conversely in the thermal infrared, brightness temperature behaves in an opposite way, thus making it possible to set a threshold value equal to the highest value of cloudy area temperatures.

During night-time the sea is characterised by greater thermal inertia and tends to keep its own daytime temperature, whereas the land cools down to a temperature even lower than the sea's temperature. Moreover, the reflectance data cannot be used and therefore the setting of the single threshold should consider the classification of a pixel (sea/land) [8] for improving cloud detection.

In the cloud detection algorithm for daytime images, upper and lower threshold values are determined from reflectance and brightness temperature histograms, while during the night-time, the dynamic threshold is calculated only from brightness temperature histograms. For both the daytime and night-time, analysis is performed separately over sea and land histograms, as illustrated in Fig. 1. If the threshold value search fails, default values are used.

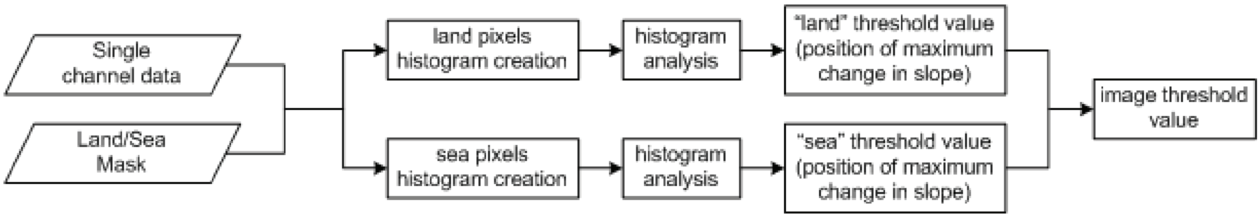

Fig. 1 Block diagram for determining the dynamic threshold for each channel considered in the presented DTCM cloud detection algorithm.

In the first phase the algorithm allows for the research of a dynamic threshold to apply differently on land and sea for 4 channels – 2 reflective and 2 thermal. The reflective channels are channel 1 (0.6 μm) and 2 (0.8 μm) for AVHRR as well as for SEVIRI. The used thermal channels are characterised by 10.8 μm wavelength (channel 4 AVHRR and 9 SEVIRI) and a 12 μm wavelength (channel 5 AVHRR and 10 SEVERI).

In the second phase it is necessary to determine whether the image is completely cloudy using a test where the average reflectance values (only daytime images) and the land and sea pixels' brightness temperature of the entire image are measured, comparing them to one another with their reference values [1] [5]. In case the image is not uniformly cloudy, threshold tests will be performed on all of the available channels and the DTCM cloud mask, where the pixels are identified as cloudy when at least one test output is "cloudy", will be produced on the way out. The algorithm's efficiency was verified through the reiterated application, prior to the threshold adjustment with a visual comparison on various channels, similarly to [5].

3. RESULTS

Examples of the cloud detection results on channel 1 reflectance data (0.6 μm) for AVHRR/NOAA on 17.03.2008 at 12.28 UTC and for SEVIRI/MSG on the same day at 12.30 UTC, are presented respectively in Fig. 2 and Fig. 3. The algorithm seems to work properly on both daytime and night-time images, even if some pixels are wrongly classified.

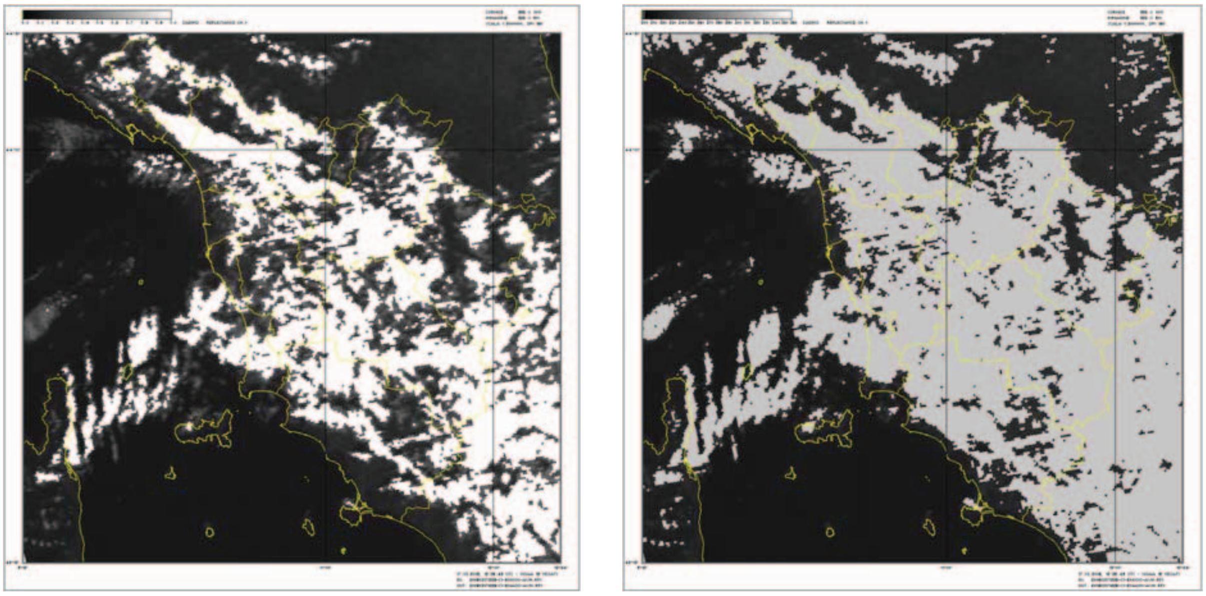

Fig. 2 Channel 1 reflectance images before (left) and after (right) processing with cloud detection algorithm. AVHRR 17.03.2008 12.28 UTC.

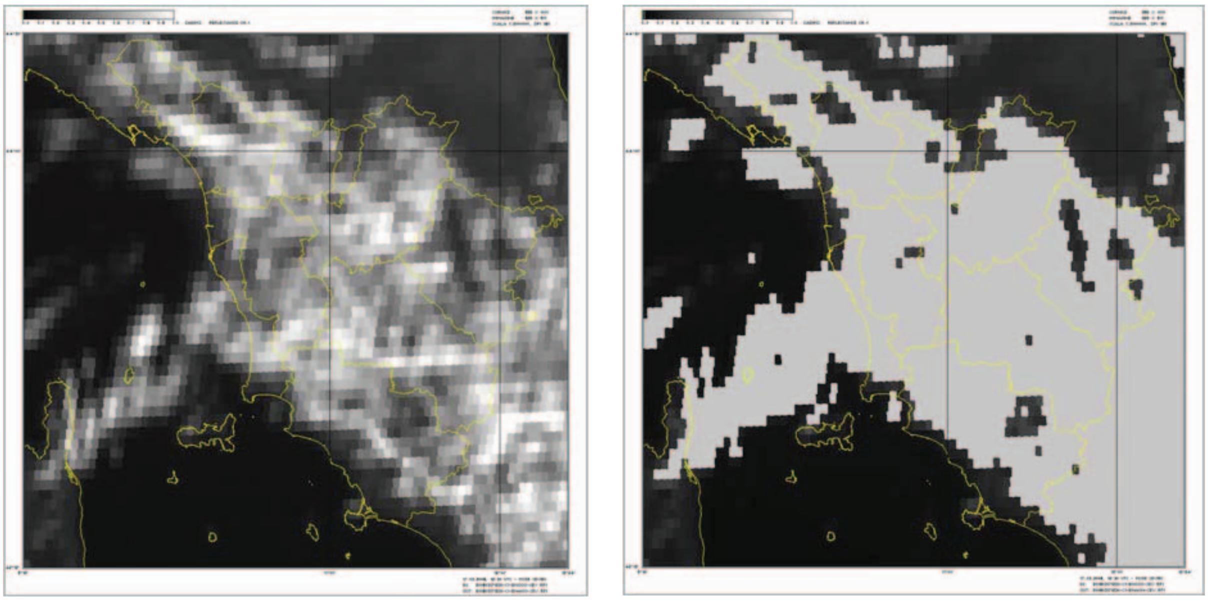

Fig. 3 Channel 1 reflectance images before (left) and after (right) processing with cloud detection algorithm. SEVIRI 17.03.2008 12.30 UTC.

4. REFERENCES

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