CLASSIFICATION OF CLOUDS WITH OBJECT ORIENTED TECHNIQUE

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ABSTRACT: Rainy clouds having high densities are considered as one of the main causes of flood events, therefore detection and classification of clouds can be very valuable for flood forecasting. In this study NOAA/AVHRR satellite images were used for object oriented classification. Sixteen bands were produced and utilized for cloud classification. This included the main five bands of NOAA/AVHRR and other important information such as albedo of band 1 and 7, brightness temperature of band 7 and 11, solar zenith and azimuth angles, land surface temperature, sea surface temperature, normalized difference vegetation index, deviation of nadir and cloud height. Multi-resolution segmentation followed by bi-spectral technique and hierarchical classification were performed using the sixteen produced layers. The obtained kappa coefficient and the overall accuracy were relatively high (kappa= 0.5336, overall Acc.= 0.525). The results of the study demonstrated that the object oriented classification can be considered as a proper method for cloud detection and classification.

INTRODUCTION

The detection and classification of clouds in meteorological satellite data with known pixel based approaches is principally based on spectral analyses and every so often simple spatial analyses are used additionally. When classifying structures performed with hundreds of pixels and relationships between them, these approaches are called conceptual methods. Object orient classification is a conceptual method that operates on groups of pixels (image objects) and defines the relationship between them. There are two advantages for Cloud classification with object oriented techniques. First, this approach reduces within-class spectral variation and generally removes the so-called salt-and-pepper effects that are typical in pixel-based classification. Second, a large set of features characterizing objects' spatial, textural, and contextual properties can be derived as complementary information to the direct spectral observations to potentially improve cloud classification accuracy (Liu and Xia 55555; Göttsche and Olesen, 55555; haji mir rahimi and bai, 55555 in persian).

The purpose of this letter is to provide a more complete evaluation of object-based cloud classification.

DATA AND METHODS

Data

In this study the classification of clouds was performed using low resolution satellite image, NOAA/AVHRR data, that is taken from northeast of Iran in august of 55555 (NOAA 55, 55; 55, UTC). It has a spatial resolution about ¹.¹ km in nadir and ⁸ spectral channels with the following wavelength ranges have shown in table ¹.

<table>
<thead>
<tr>
<th>spectral channels</th>
<th>Range of electromagnetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch1: 0.63 - 0.7445μm</td>
<td>VIS (visible)</td>
</tr>
<tr>
<td>Channel</td>
<td>Wavelength</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>Ch1</td>
<td>0.55 – 0.67 μm</td>
</tr>
<tr>
<td>Ch2</td>
<td>0.73 – 1.1 μm</td>
</tr>
<tr>
<td>Ch3</td>
<td>1.55 – 1.75 μm</td>
</tr>
</tbody>
</table>

Table 1. Channel of NOAA/AVHRR

\subsection{Methods}

In this study, we performed the image processing (corrections and calibrations) and clipping the study area from images, primarily. Then the cloud classification was applied. Figure 1 is a schematic diagram that illustrates the steps and type of need data in this study. And Figure 2 and 3 show the visible and infrared bands respectively.

In general, the most effective method for identifying individual cloud types is to obtain a Visible and an IR image of the same scene. The Visible (VIS) channels 1 and 3 of the data were processed for albedo. The VIS image used to identify cloud shapes, textures, organizational patterns, and thicknesses. In general, the thicker a cloud is, the higher its albedo and the brighter it will appear in visible imagery. Thin clouds are often very dark or transparent in visible imagery. Cloud texture refers to its appearance in visible imagery.

Visible satellite data then was compared to an IR image in order to determine the height of the clouds. The IR channels 2, 4, and 5 of the data were processed for brightness temperature. In general, the higher a cloud is, the colder it is. In IR imagery, therefore, lower, warmer clouds will appear darker while high, cold clouds will appear brighter. We put together all this information and performed object oriented method with ecognition software and made reliable assessments of what types of clouds are present in the image. Additional information such as from criteria, textual or contextual information of the segments then are used in an appropriate way to derive improved classification results.
The important first step in object orient classification is segmentation. The segmentation algorithm does not only depend on the single pixel value, but also on pixel spatial continuity (texture, topology, shape, channel means, standard deviation, etc) (Mansor et al., 55). The Sixteen components are produced with PCI Geomatica in this study. The five main bands that there are in satellite images (primary components) and the other eleven components such as albedo and brightness temperature of main bands, solar zenith and azimuth angles, Land Surface Temperature (LST) & Sea Surface Temperature (SST), Normalized Difference Vegetation Index (NDVI) and deviation of nadir and cloud height are secondary components.

Form sixteen components, the ten components use directly and others have the same effects on classification. The multiresolution segmentation is selected in this study. This results to a condensing of information and a knowledge-free extraction of image objects. For this method the used AVHRR channels, brightness temperatures of band 4 and 5 and cloud height are weighted by \( \gamma \), whereas the Digital Elevation Model (DEM), LST & SST and NDVI that show the free cloud areas, are weighted by \( \gamma \delta \) (Göttsche and Olesen, 55). Since the clouds with medium area and more are important for this study, a fairly medium scale of \( \delta \) is chosen for the finest segmentation (level \( \gamma \) that called analysis level).

Segmenting clouds were produced using infrared or albedo images followed by bi-spectral cloud classification technique. Bi-spectral techniques based on the relationship between cold and brightness temperature of clouds were also used to evaluate classification. Figure 5 shows the multiresolution segmentation that applied on image.
Multiresolution segmentation in analysis level

In remote sensing studies, we cannot detect a specific cloud in a range of Digital number in visible or infrared images exactly. For example, the cumulonimbus clouds (Cb) in each region and time can be detected with various range of digital number. But studies show that this type of cloud is brighter than others in VIS and IR images or stratus clouds (St) are darker than others in IR images. The other types of clouds can be detected similarly that is showed in figure but texture, shape, and thickness of clouds are useful options for decision. Figure is the principle of bi-spectral technique in this study.

RESULTS AND DISCUSSIONS

In this study, classes were identified that included a non-cloud class (sea and terrain) and cloud classes (Ns, Ci, Cb, Cu, Cg, Sc, St). After detecting the classes and scrutiny of features (mean, standard deviation, to super object, shape (area and density) and texture (homogeneity, contrast, and entropy), classification was carried out. The nearest neighbor classification of level object was performed for mean and standard deviation of AVHRR channels of, and . The relationships between objects were included in the hierarchical classification for getting better results. The classifications of clouds were performed in level called cloud level. The result of classification illustrated in figure.

Since the detected cloud in sky of each area is the dominant cloud on that hour and the other type of clouds may be existed during the day, so collecting of control points for accurate assessment is not possible. So, the regions that have the most adaptation with bi-spectral cloud classification theories were used as training samples optically. The NIR and IR channels, and of the data were processed for temperature and brightness. In IR images, high clouds are cold, so the colors typically highlight the colder regions. Mid height clouds with TB below were identified as cumulonimbus cloud. Darker clouds in IR images were associated with warm stratus, Strato cumulus, cumulus clouds, and thin cirrus cloud that were colder than others. Using this knowledge and bi-spectral technique, the sampling areas were selected and error matrix and kappa coefficient performed using TTA MASK in eCognition software. The obtained kappa coefficient was equal of and the overall accuracy is that.
illustrate the accuracy of classification is high. The window of error matrix based on TTA Mask is showed in figure 7.

Figure 7. Error matrix based on TTA Mask

References


