Study on Cloud Classifications by using AVHRR, GMS-5 and Terra/MODIS satellite data

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NOAA/AVHRR NEURAL NETWORK CLOUD CLASSIFICATION TECHNIQUES

The field of neural networks can be thought of as being related to artificial intelligence, machine learning, parallel processing, statistics, and other fields. The attraction of artificial networks is that they are best suited to solving the problems that are the most difficult to solve by traditional computational methods. We use the Back-Propagation (BP) artificial neural network in this cloud classification study, which is used widely in many fields.

In this study, the sample database of clouds, land and water is built based on AVHRR 4 channels data which includes more than thirty thousands GMS-5 pixel samples and more than twenty thousands one pixel samples. Theory analysis and experiment show that not only 4 channel data can be used to distinguish clouds and land and water but also the band combination with each other can do so. For example, the differences of AVHRR channel 4 and 5 can be used to distinguish water particles cloud and land particle cloud because the biggest absorption difference between water particles and no particles is near 12µm. Based on theory analysis and experiments, 8 features are extracted from 5 channels AVHRR data for 9 pixels samples, which involve spectrum features, gray features, channel difference features and the gray scale statistical features. 20 features are selected using pop-step distinguish analysis method, which includes spectrum features, gray features. 20 features are extracted from 5 channel AVHRR data for single pixel samples.

The inputs of our AVHRR automatic cloud classification system are 5 AVHRR channels data and outputs are classified gray image. Cloud classified image involves cumulonimbus, cumulus congestus, cumulus, cirrus, middle cloud, low cloud and land, water and unknown pixel.

Cloud classification experiment of sample database is done using neural network method. The neural network model has 29 input nodes, 14 hidden layers and 4 output nodes (0-1-1-1). More than three thousand samples selected randomly are used to train the neural network model. The other independent samples are used for testing. Testing result shows classification accuracy is about 78% for 8*8 pixels samples. Classification accuracy of 8*8 pixels samples is a little better than single pixel sample, than 8*8 pixels scale methods through testing using AVHRR data. Although neural network model is used in the practical application to one satellite image single pixel cloud classification neural network model is better.

MODIS CLOUD MASK AND CLOUD CLASSIFICATION TEST CASES

A simple cloud mask test is done using some thresholds as follows: \( R_{T1} \leq R_{T2} \leq R_{T3} \leq R_{T4} \leq R_{T5} \). Each threshold \( R_T \) on AVHRR channel 2, 3, 4, 5 are pixel will be classified as cloud or non-cloud. Different thresholds testing give different cloud classified imagery, the differences between channels can be classified as cloud if most of the thresholds testing flag this pixel as cloud. After above processing, land and water and unknown pixel first are classified as land or water pixel. Figure 5 is an example of the cloud mask using MODIS data over China (4 July 2001). The left image is composited image of hand, land and cloud and the right one is cloud classified image. In cloud classified imagery, the green regions are land, blue regions are water, white, unknown pixel are areas are cyan, and dark yellow areas are low-level cloud. Over the Yangtze River drainage basin there are other cloud system of the tropical cyclonic.

SUMMARY AND CONCLUSION

This paper discussed cloud mask and cloud classification methods using the different satellite data. Some conclusions can be drawn from the study as follows:

1. The most cloud classification methods are not efficient and can not distinguish between a few kinds of clouds. In this paper we discussed the automated pixel-scale neural network method, the automated 9*9 pixels neural network method, and the automated pixel-scale multi-spectrum threshold detection to detect and classify clouds. For neural network cloud classification methods has higher classification accuracy but our data can not recognize it. A perfect sample database that it includes almost all case in the different season and in the different area will need large resources. For pixel-scale multi-spectrum threshold techniques is it relatively easy to adopt thresholds to varying meteorological conditions, earth surface types, viewing geometry using external data. One of the main disadvantages is that the thresholds used need to be tuned frequently.

2. Using MODIS data, we can distinguish between cloud and clear sky more easily and recognize the different types of clouds more clearly. Snow and low-level cloud is can be easily distinguished using MODIS bands (5,6,7,8), and hand is helpful for distinguishing between the ice and cloud water cloud. MODIS has measurement at three wavelength in the window, 1A, 1B, and 2µm, which are very useful in determination of cloud free atmosphere, and their combination are helpful to determine the thin cirrus.

3. It shows that using pixel-scale methods are more suitable for practical application than 9*9 pixels scale methods through testing using AVHRR data. Although classification accuracy of 9*9 pixels samples is a little better than single pixel sample, when neural network model is used in the practical application for a satellite image single pixel cloud classification neural network model is better.

4. Although the spatial resolution of the MODIS data is lower than AVHRR and MODIS data, his higher time resolution makes it reflect weather system evolution very precise. It can show cloud classification in the different season using MODIS data, but its higher time resolution makes it reflect weather system evolution very precise. It can show cloud classification in the different season using MODIS data, but its higher time resolution makes it reflect weather system evolution very precise.