A RETRIEVAL ALGORITHM FOR AEROSOL OPTICAL DEPTH FROM MODIS MULTI-SPATIAL SCALE DATA BASED ON MUTUAL INFORMATION

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ABSTRACT

Retrieving aerosol optical depth (AOD) from satellite remote sensing data is a very complex task. This is because one must separate surface and atmospheric contributions to the observed signal at the satellite level and the aerosol contribution has to be separated from the atmospheric signal [1]. The Dark Dense Vegetation (DDV) algorithm for retrieving AOD is used in NASA AOD products from MODIS (Moderate Resolution Imaging Spectroradiometer) data [2]. However, the criterion of dark pixel is so strict that many areas which have high surface reflectance cannot fit it. As a result, there are many no-value areas on the MODIS aerosol products maps over global.

Xue and Cracknell (1995) proposed an operational bi-angle approach model for retrieving AOD and the Earth surface albedo. By using this model, AOD and the Earth surface albedo can be retrieved from NOAA/AVHRR data at the same time [3]. Tang, Xue et al. (2005) developed the model and proposed a new algorithm called the synergy of TERRA and AQUA MODIS data (SYNTAM) or MODIS multi-satellite algorithm. In this algorithm, there are two basic assumptions: (1) shortwave radiation transfers in a non-absorbing atmosphere, which means there is no absorption effect in the atmosphere, (2) for the two pass observations of very short time interval, the ground surface bidirectional reflectance properties, aerosol types and properties do not change other than rainfall or other events occurring between the two overpasses. By SYNTAM algorithm, AOD and surface reflectance both with 1km by 1km resolution can be retrieved [4].

Based on the research results above, a retrieval algorithm for AOD from MODIS multi-spatial scale data with 1km x 1km, 500m x 500m and 250m x 250m resolution based on mutual information (MI) is proposed. The concept of mutual information represents a measure of relative entropy between two sets, which can also be described as a measure of information redundancy. From this definition, it can be easily shown that the mutual information of two images is maximal when these two images are identical [5]. The data used are MODIS data with 1km x 1km, 500m x 500m and 250m x 250m resolutions which are covered Heihe Watershed, in Gansu Province, China, on 5th, July, 2008. Firstly, we retrieved AOD from TERRA and AQUA MODIS data with 1km x 1km resolution using MODIS multi-satellite algorithm. Secondly, we construct an interpolation formula by maximizing MI between the two images which is used to transform low resolution MODIS TOA(Top-Of-Atmosphere) reflectance data into high resolution MODIS TOA reflectance data. Then we apply this interpolation formula to AOD with 1km x 1km resolution and get the high resolution AOD (500m x 500m and 250m x 250m). The results of 1km x 1km, 500m x 500m and 250m x 250m AOD are showed in Fig. 1-4.

Compared with the 500m x 500m AOD retrieved by MODIS multi-satellite algorithm [6], the AOD with 500m x 500m resolution got by MI algorithm is coincident. Preliminary validation result comparing with CE318 Sun Photometer measured data shows good accuracy and promising potential. The AOD with 500m x 500m and 250m x 250m resolution which we retrieved by MI algorithm can be used for atmosphere correction of MODIS data with the corresponding resolution. The Further research work is ongoing.

***Index Terms*—**aerosol optical depth (AOD), mutual information (MI), remote sensing retrieval, MODIS, multi-spatial scale

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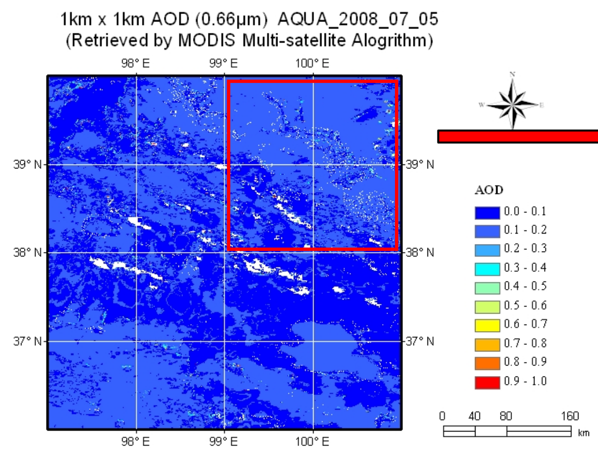

Fig. 1 1km x 1km AOD over Heihe Watershed retrieved by MODIS multi-satellite algorithm from TERRA MODIS data on 5th, July, 2008

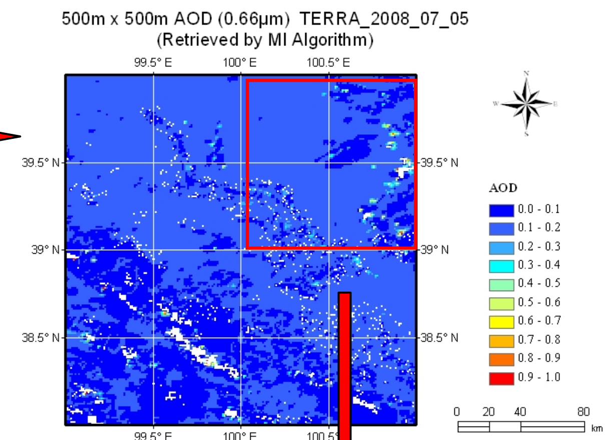

Fig. 3 500m x 500m AOD over Heihe Watershed retrieved by MI algorithm from TERRA MODIS data on 5th, July, 2008

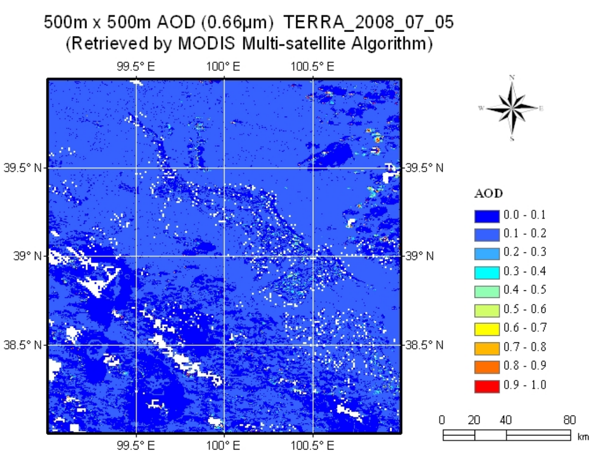

Fig. 2 500m x 500m AOD over Heihe Watershed retrieved by MODIS multi-satellite algorithm from TERRA MODIS data on 5th, July, 2008

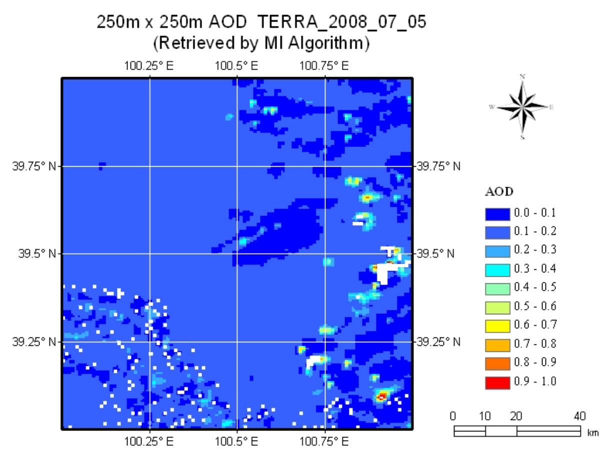

Fig. 4 250m x 250m AOD over Heihe Watershed retrieved by MI algorithm from TERRA MODIS data on 5th, July, 2008