AOT Retrieval based on CR algorithm integrated with BRDF model in urban area

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ABSTRACT

Aerosol properties over land have mainly been retrieved using passive optical satellite techniques, but it is well known that this is a very complex task. This is because one must separate surface and atmospheric contributions to the observed signal at the satellite level. Several algorithms have been applied to satellite datasets to solve the inverse problem of separating the surface and atmospheric scattering contributions. Over dark dense vegetation (DDV) areas, for the aerosol contribution is dominant in the observed signal, it can easily separate the aerosol from the surface, so DDV method is one of the effectively method, and has been widely used to retrieve aerosol optical thickness (AOT). However, in bright areas, such as urban, because the aerosol contribution is small compared to the surface, it is difficult to retrieve the aerosol information. To solve this problem, Tanre et al (1988) has suggested an method, called contrast reduction (CR), which determines aerosol optical thickness from atmospheric transmission, based on ratio of transmission between several images, that include a relativity clear image. This method has been applied to calculate the AOT in the desert and semiarid areas. But in the urban, for the complex structure, the CR method can not work well. In this paper, an improved method is proposed to calculate the contrast reduction value in urban area, which has a higher stability and accuracy compared with traditional methods, and has been applied to AOT retrieval in the urban areas based on the MODIS data.

Present Algorithms for retrieving the aerosol properties assume that the surface is Lambertian surface. The error resulting from this approximation is small for dark surfaces used to derive the aerosol optical thickness. But in the urban area, for the high reflectance and large heterogeneity, Lambertian assumption will lead to a large error. It is necessary, therefore, to develop BRDF model to estimate the urban areas reflectance accurately. In this paper, the urban BRDF model has been developed and applied to the contrast reduction AOT inversion algorithm. Two important factors are vegetation coverage in urban areas and the geometry structure of the urban BRDF model. A new vegetation coverage estimation method is suggested and the geometry structures are estimated based on statistical value. This urban BRDF model was integrated with the improved CR method to inverse aerosol optical thickness in Beijing area with the 250m MODIS data.

In our inversion algorithm, the first step is to preprocess data, including geometric correction, cloud mask and chosen the clear image, the atmospheric correction for the Secondly, the structural function, which used to calculate the ratio of transmission, is computed for each image to be retrieved. The next step is to build look up table (LUT) using Second Simulation of the Satellite Signal in the Solar Spectrum (6S) software. Then the AOD can be retrieved according to geometric parameters and the ratio of transmission for each image. To reveal the necessity of the BRDR considering in the urban area, we retrieve the aerosol optical thickness in two different ways: with BRDF considering and without BRDF considering.

We selected six different days MODIS images (2004/10/6, 2004/10/6, 2004/10/13, 2004/10/14, 2004/10/16, 2004/10/18), that include a clear image (2004/10/13), around Beijing city, which have the same geographical area and the different geometrical condition. The retrieved aerosol optical thickness from MODIS data are compared to Aerosol rootic network(AERONET) Beijing station measurements and reported in Table 1. The comparisons show that the aerosol optical thickness is retrieved within 0.1 when the aerosol optical thickness is low, and the relative error is less than 25% when it is high.

Table1 Aerosol optical thickness obtained from the satellite data and from the ground

Date	Ground measurement	Satellite retrieving with BRDF considering	errors
2004-10-06	0.8134	0.7420	0.0714
2004-10-09	1.1225	1.0851	0.0374
2004-10-14	0.1116	0.13946	0.02786
2004-10-16	0.2922	0.40819	0.066
2004-1018	0.9104	1.03352	0.12312

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