MONITORING THE HEAVY FOG USING AOD DERIVED FROM MODIS DATA

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ABSTRACT

On Oct. 28th, 2009, a heavy fog hit East China so that the visibility of these regions was diminished remarkably (See Fig. 1). In some areas, it even fell to as low as 50m. As a result, many highways were closed and some flights were delayed or cancelled. The air quality also became very bad.

To monitor the heavy fog effectively and real-timely and know its geographic distribution quantitatively, aerosol optical depth (AOD) retrieval from satellite remote sensing data is necessary. AOD is the integral of the aerosol extinction coefficient over vertical path from the surface to the top of the atmosphere (TOA). It can be used to describe the attenuation of electromagnetic radiative transfer in air and to indicate the fog scope and its relative thickness.

Retrieving AOD from satellite remote sensing data is a very complex task because it is difficult to separate the surface and atmospheric contributions from the observed signal at the satellite level [1]. There are many aerosol retrieval algorithms for different satellites and sensors [2]. The mainstream algorithms of satellite aerosol remote sensing over land may be ‘Dark Target’ and ‘Deep Blue’ [3-5], which are adopted by MODIS aerosol products algorithms. However, MODIS aerosol products have 10km x 10km spatial resolution at nadir and each algorithm is applicable to a specific surface type. Xue and Cracknell proposed an operational bi-angle approach model for retrieving AOD and the Earth surface albedo [6]. In 2005, Tang et al. proposed a new algorithm for AOD retrieval called the synergy of Terra and Aqua MODIS data (SYNTAM) [7]. By this algorithm, AOD and surface reflectance both with 1km x 1km resolution can be retrieved simultaneously.

Using SYNTAM algorithm, we get the 1km AOD at 470, 550 and 660 nm from MODIS data over East China (110º-123ºE, 30º-42ºN) on Oct. 28th, 2009 (See Fig. 2). Comparing with MODIS aerosol products (See Fig. 3 and Fig. 4), it can be seen that the AOD values retrieved by ‘Deep Blue’ are invalid in many regions because the algorithm is not applicable when the surface is covered by the heavy fog. The result of SYNTAM is

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coincident with the one of 'Dark Target'. Because in our processing procedure, we used MOD/MYD35 cloud mask product to mask MODIS L1B data, most of the pixels of the ocean are marked as 'cloud-pollution' (See Fig. 5), the AOD results over ocean are invalid.

To validate our results, we collect the AERONET data synchronized with the satellites in the area. The validation results show that the results retrieved by SYNTAM have good precision. The average relative error is about 10% and the correlation with AERONET data is as high as 0.88 (See Fig. 6).

Comparing with the MODIS RGB composite image, we can see that the areas covered by heavy fog have high AOD values, usually higher than 0.8. The thickest regions are mainly in Shandong, Hebei and Henan provinces. Thus, AOD results can index the fog scope, geographic distribution and the relative thickness. The reason why the fog is so heavier may due to the temperature inversion which is also discussed in this paper. Because our AOD result has higher resolution than MODIS aerosol product, it can provide more details and information. Therefore, it is an effective method of monitoring the heavy fog.

Index Terms**—**aerosol optical depth (AOD), air monitoring, satellite remote sensing, heavy fog, MODIS

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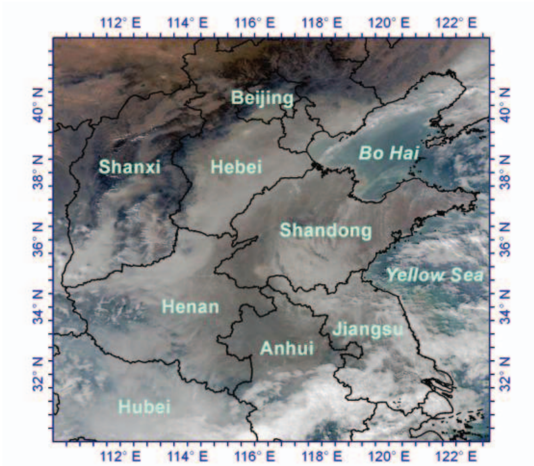

Fig. 1. Aqua MODIS RGB composed image (R for Band 1; G for Band 4; B for Band 3), Gaussian enhancement is made.

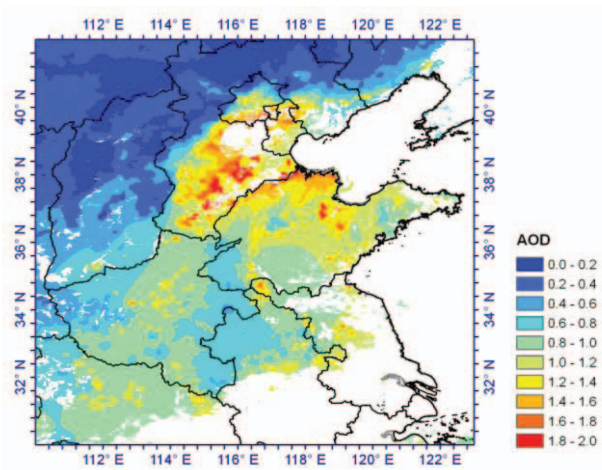

Fig. 2. AOD at 550nm retrieved by SYNTAM algorithm from Aqua MODIS data

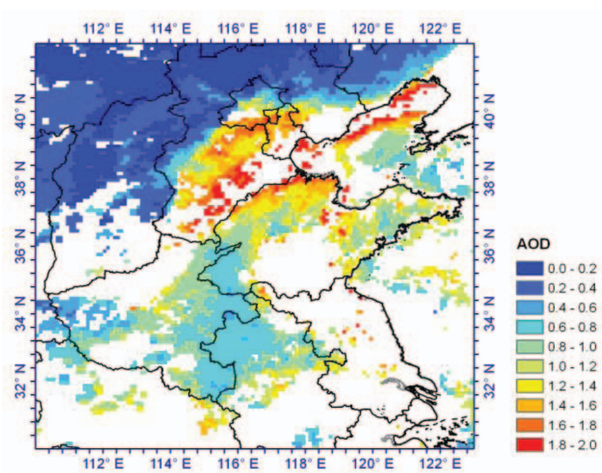

Fig. 3. AOD at 550nm of MODIS aerosol product, MYD04, retrieved by 'Dark Target' algorithm

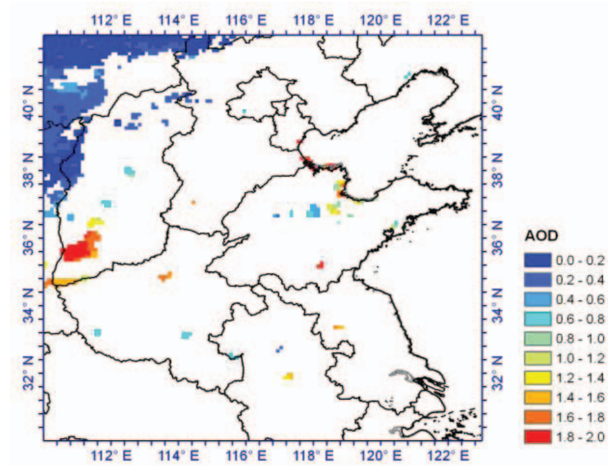

Fig. 4. AOD at 550nm of MODIS aerosol product, MYD04, retrieved by 'Deep Blue' algorithm

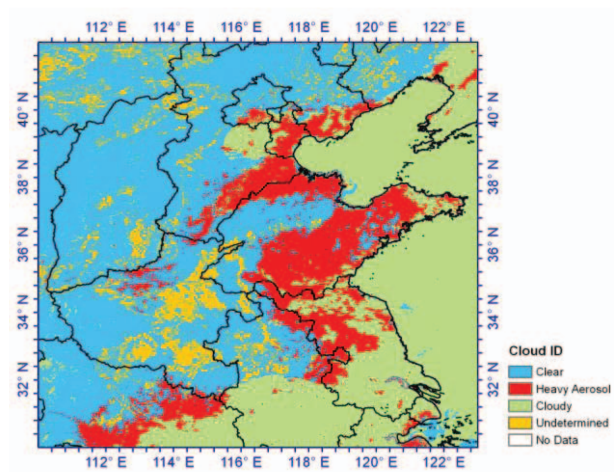

Fig. 5. Cloud ID retrieved from MODIS cloud mask, MYD35

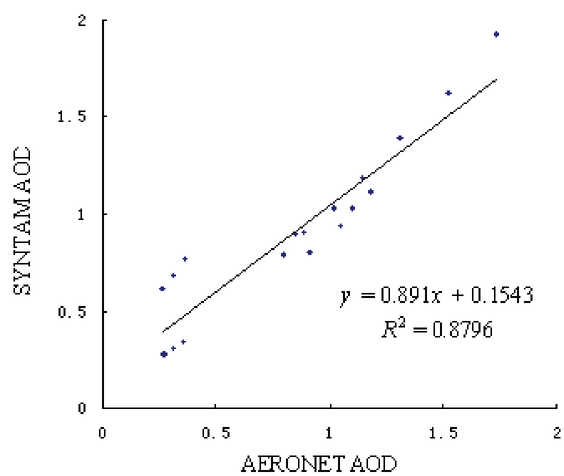

Fig. 6. Comparison of AOD between SYNTAM results and AERONET data