AEROSOL OPTICAL THICKNESS FROM MODIS DATA AT 500M RESOLUTION FOR TWO EXTREME AEROSOL EVENTS ANALYSIS

Ying Wang[a,c], Yong Xue[a,b], Jie Guang[a], Yingjie Li[a,c], Linlu Mei[a,c], Hui Xu[a,c], Jianwen Ai[a,c], Qiang Li[d]*

[a] State Key Laboratory of Remote Sensing Science, Jointly Sponsored by the Institute of Remote Sensing Applications of Chinese Academy of Sciences, and Beijing Normal University, Institute of Remote Sensing Applications, Chinese Academy of Sciences, P.O. Box 9718, Beijing 100101, China

[b] Department of Computing, London Metropolitan University, 166-220 Holloway Road, London N7 8DB, UK

[c] Graduate University of Chinese Academy of Sciences, Beijing 100049, China

[d] College of Information Science and Engineering, Shandong University of Science and Technology, Qingdao, Shandong 266510, China

E-mail: {wangy_86@sina.com, y.xue@londonmet.ac.uk}

1. INTRODUCTION

It is well-known that aerosols play an important effect in climate-related processes, such as direct interactions with radiation and indirect effect by modulating precipitation and modifying cloud-radiative properties. Besides, aerosol effects are also enormous in regional/local atmospheric phenomena. Extreme aerosol events, such as dust storms and haze/fog on a regional scale, can greatly influence regional climate, air quality and consequent people's health and daily life. Fine resolution satellite data can be used to provide a macro-view of bursting aerosols, in which AOT would be the sole most synthetic variable.

Thick haze and fog settled over much of China on Oct. 28, 2009. Visibility dropped to zero in parts of eastern Washington, USA on Oct. 4, 2009, as a large dust storm blew through. In this article, we derived AOT maps at 500m resolution from MODIS (or Moderate Resolution Imaging Spectroradiometer) data together with NASA AOT products at 10km resolution, to analyze these two aerosol events.

2. MATERIALS AND METHODS

* Corresponding author

Tang et al.[1] employed Xue and Cracknell's research [2] results and the assumption that the surface reflectance is approximated by a part that describes the variation with the wavelength and a part that describes the variation with the geometry [3-5], setting forth the synergy of TERRA and AQUA MODIS data (SYNTAM) model:

$$A_{j,\lambda_i} = \frac{\left(A'_{j,\lambda_i} b - a_j\right) + a_j\left(1 - A'_{j,\lambda_i}\right) e^{\left(a_j - b\right)\varepsilon\left(0.00879\lambda_i^{-4.09} + \beta_j \lambda_i^{-\alpha}\right)\sec\theta'_j}}{\left(A'_{j,\lambda_i} b - a_j\right) + b\left(1 - A'_{j,\lambda_i}\right) e^{\left(a_j - b\right)\varepsilon\left(0.00879\lambda_i^{-4.09} + \beta_j \lambda_i^{-\alpha}\right)\sec\theta'_j}} \tag{1}$$

$$K_{\lambda_i} = A_{1,\lambda_i} \Big/ A_{2,\lambda_i} \tag{2}$$

where i = 1,2, respectively, stand for the observation of TERRA-MODIS and AQUA-MODIS; j = 1, 3, 4, 7, respectively, stand for four visible spectral bands; $a = \sec\theta$; b = 2; ε = the backscattering coefficient, typically 0.1; θ = the solar zenith angle, is calculated from latitude, longitude and time; θ = the zenith angle of the sensor; A = the Earth's surface reflectance; A' = the Earth's system reflectance; α = the wavelength exponent in angstrom's turbidity formula; β = angstrom's turbidity coefficient.

MODIS 500m data sets are selected for the retrieval. We adopt Levenberg-Mauquardt algorithm as the approximate numerical solution, and transform the degraded continuous division to combination of multiplication and subtraction, both of which will improve the robustness of results.

3. RESULTS, VALIDATION AND ANALYSIS

MODIS 500m retrieval results are validated in Fig. 1 with AERONET sites that the correlation coefficient R2 between retrieved AOT and AERONET AOT is 0.87. It confirms that the retrieval would be trustable to some extent. Together with mapped accompanying with NASA MODIS AOT product at 10km resolution. Also displayed are the photo-like images captured by the MODIS on NASA's Aqua satellite.

The snapshot view over East of China (Fig. 2(a)) shows that the thickest haze conforms to the low-lying contours of the Yellow River Valley and the western half of the North China Plain near the Luliang Mountains. Retrieved AOT mapping at 500m resolution (Fig. 3(a)) reveals much of the tendency, and is smoother and covers more than MODIS AOT product at 10km resolution (Fig. 3(b)). A thick, rippling plume of dust runs northeast to southwest through the center of the snapshot view (Fig. 2(b)) over Washington State, USA. Dust stretches as far south as the cities of Pasco and Kennewick, which sit on opposite banks of the Columbia River. However, this phenomenon is not obvious at 500m resolution AOT mapping (Fig. 4(a)) for the comb-teeth cloud mask. Fig. 4(a) and 4(b) display different clear areas, because MO/YD04 products adopt different cloud-screening scheme from MO/YD35 cloud mask products. It should be noted that SYNTAM AOT mappings exclude AOT over ocean.

4. CONCLUSIONS

Two extreme aerosol events' AOT is retrieved with spatial resolution 500m over East of China and Washington State, USA, respectively. Validation confirms that the retrieval would be trustable to some extent. Retrieved AOT at 500m resolution, NASA's MODIS AOT products at 10km resolution and NASA's snapshot views are utilized to analyze these two extreme aerosol events. Retrieved AOT mappings at 500m resolution reveal much of the tendency, and are smoother and cover more than MODIS AOT products at 10km resolution, which would complement NASA products.

Index Terms— Aerosol Optical Thickness, MODIS, Extreme Aerosol Events

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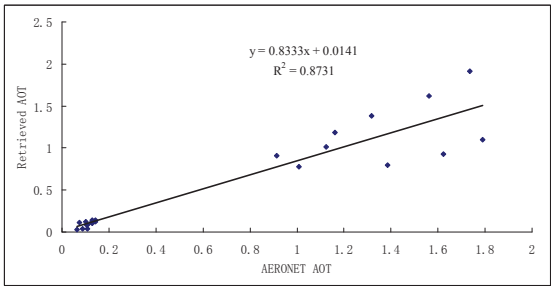
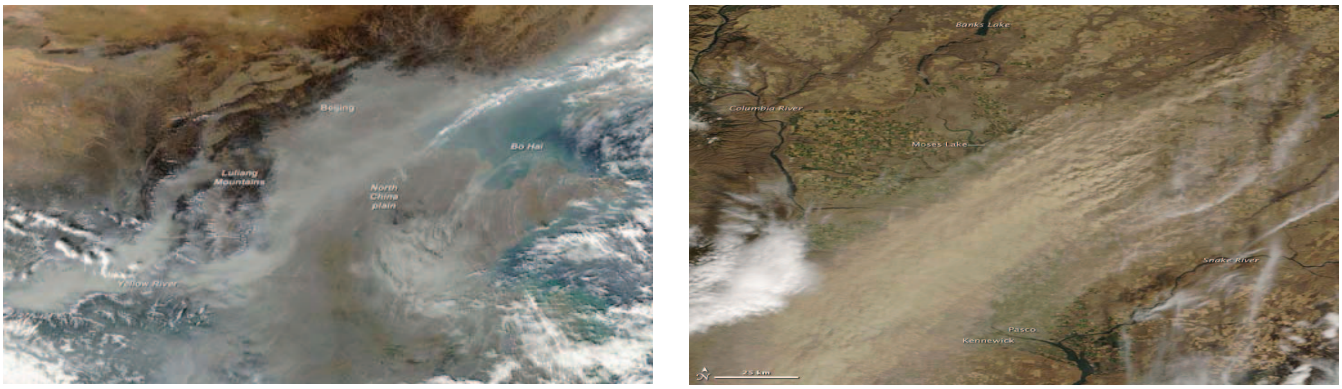
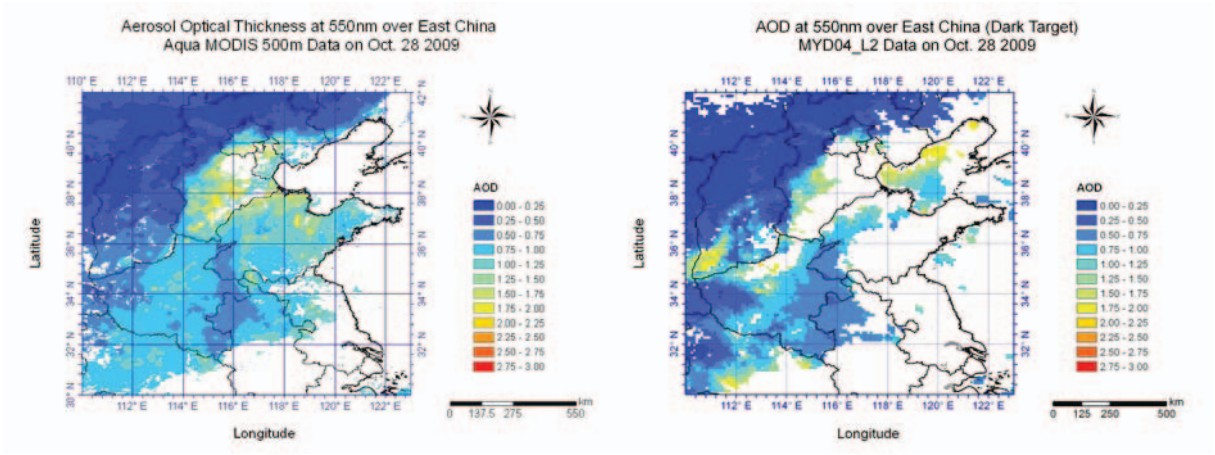


Fig. 1. Comparison between retrieved AOT and AERONET AOT.



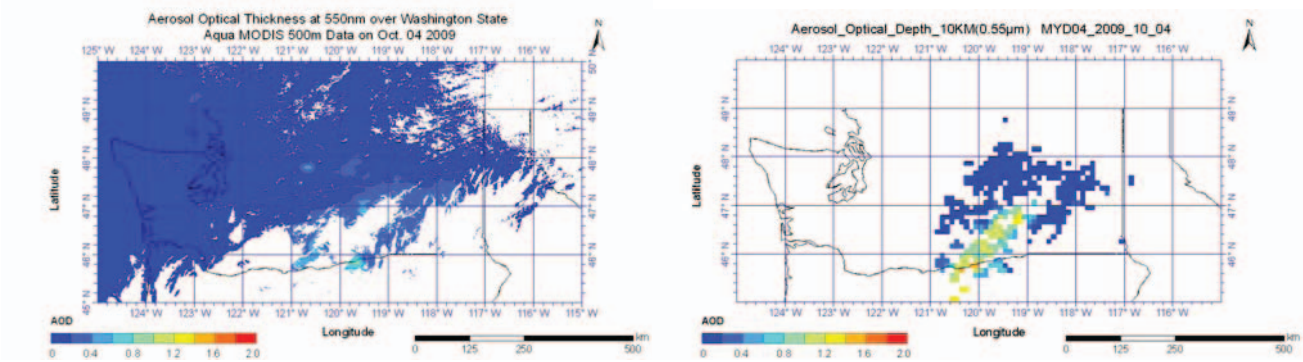
(a) (b)

Fig. 2. MODIS snapshot view for settled thick haze and fog over much of China on Oct. 28, 2009 (a), and a large dust storm in parts of eastern Washington State, USA on Oct. 4, 2009 (b).



(a) (b)

Fig. 3. Retrieved MODIS 500×500m AOT (a) and MODIS 10×10km AOT product (MYD04_L2) (b) at 550nm over East of China aboard Aqua on Oct. 28, 2009.



(a) (b)

Fig. 4. Retrieved MODIS 500×500m AOT (a) and MODIS 10×10km AOT product (MYD04_L2) (b) at 550nm over Washington State, USA aboard Aqua on Oct. 4, 2009.