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Retrieval of Aerosol Optical DepthBased on MODIS

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Abstract. Aerosol plays an important role in global climate effect, and Aerosol Optical Depth (AOD), as one of its important parameters, can not only monitor the turbidity of the atmosphere, but also is an important index of atmospheric correction quality in remote sensing. Urban agglomeration in the middle reaches of the Yangtze River is a key national-level urban agglomerations in China, and its rapid urbanization leads to the aggravation of urban diseases such as disorderly development of cities, waste of resources and environmental pollution, and the research on ecological environment problems of urban agglomerations is also the current key project.In view of the above problems, this paper studies the AOD inversion and its spatial and temporal distribution in the middle reaches of the Yangtze River, in order to provide important scientific materials for environmental monitoring and satellite atmospheric correction quality inspection.

1 Introduction

With the rapid development of economy and the acceleration of urbanization, environmental problems have seriously restricted the development of cities, especially air pollution, which seriously threatens the socio-economic development and the physical and mental health of the people [1-3]. Urbanization and industrialization are the inevitable trends of current social and economic development. Therefore, the consumption of coal, petroleum and other energy sources is increasing rapidly, and a large number of toxic and harmful gas pollutants are discharged into the atmosphere, which has caused great adverse effects [4-7].

Urban agglomerations in the middle reaches of the Yangtze River is a key national-level urban agglomerations in China, and its rapid urbanization leads to the aggravation of urban diseases such as disorderly development of cities, waste of resources and environmental pollution, and the research on ecological environment problems of urban agglomerations is also the current key project[8]. In April 2018, when inspecting the Yangtze River, General Secretary Xi Jinping pointed out that "the Yangtze River is the mother river of the Chinese nation and must be well protected", and further emphasized at the symposium on deepening the development of the Yangtze River Economic Belt, "correctly grasp the relationship between ecological environmental protection and economic development, and explore new ways to promote ecological priority and green development in a coordinated manner". To promote the green development of the Yangtze River Economic Belt, the key is to handle the relationship between green water, green mountains, golden mountains and silver mountains[9-11].

In this paper, the atmospheric environmental quality of urban agglomeration in the middle reaches of the Yangtze River is quantitatively evaluated, in order to understand the atmospheric environmental conditions in this region and provide some theoretical reference for future decision-makers of urbanization development.

2 Materials and Methods

2.1 Study area

The urban agglomeration in the middle reaches of the Yangtze River with Wuhan as the center is a super-large state-level urban agglomeration formed by Wuhan City Circle, Changsha-Zhuzhou-Xiangtan City Group and Poyang Lake City Group as the main bodies. In April, 2015, the State Council issued the Development Plan of Urban Agglomeration in the Middle Reaches of the Yangtze River, which made it clear that the urban Agglomeration in the Middle Reaches of the Yangtze River consists of 31 cities centered on Wuhan, Changsha and Nanchang. The planning scope includes Wuhan, Huangshi, Ezhou, Huanggang, Xiaogan, Xianning, Xiantao, Qianjiang, Tianmen, Xiangyang, Yichang, Jingzhou and Jingmen in Hubei Province, Changsha, Zhuzhou, Xiangtan, Yueyang, Yiyang, Changde, Hengyang and Loudi in Hunan Province, and Nanchang and Jiujiang in Jiangxi Province.

The urban agglomeration in the middle reaches of the Yangtze River is an important part of the Yangtze River Economic Belt, and it is also a key area to implement the

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strategy of promoting the rise of the central China, deepening the reform and opening up in all directions and promoting new urbanization, which occupies an important position in China's regional development pattern.

2.2 Data sources

Earth satellite was jointly launched by the United States, Japan and Canada on December 18th, 1999. It is a sun-synchronous polar-orbiting satellite with an orbital altitude of 705 kilometres, passing by at about 10:30 am local time every day. Terra satellite carries five sensors, among which the medium resolution imaging spectrometer is the most widely used atmospheric monitoring instrument. With its vast observation area of 2330 kilometres, MODIS can see every point in the world in 36 discrete spectral bands every 1-2 days. Therefore, compared with any other Terra sensor, MODIS tracks the vital signs of the earth in a wider range. This extensive space coverage enables MODIS and other sensors to help scientists determine the impact of clouds and aerosols on the Earth's energy budget. MODIS can measure aerosol characteristics. Aerosol enters the atmosphere from man-made sources, such as pollution and biomass burning, and natural resources, such as sandstorms, volcanic eruptions and forest fires. MODIS can also measure the frequency and distribution of cloud properties (such as the distribution and size of cloud droplets in water and ice clouds). MODIS helps scientists determine the vertical distribution of water vapour content and temperature in the atmospheric column, which is very important for understanding the earth's climate system. In addition, MODIS is very suitable for monitoring the changes of biosphere and surface, which provides a new insight for the operation of the global carbon cycle[12-15].

The MODIS satellite remote sensing image data used in this paper are all from casa-lads Web official website; Only by selecting the corresponding sensor type, image acquisition time and tile position of the study area in turn on the web page, the corresponding remote sensing data can be searched one by one and downloaded. The data in this paper include the data of five time periods from 2016 to 2020[16].

2.3 Research methods

In this paper, the urban agglomeration in the middle reaches of the Yangtze River are taken as the research area, and the period from May 2016 to May 2020 is taken as the research period. Collect MODIS satellite remote sensing images, meteorological data and other related data in different time period. The MODIS images are pre-processed and geometrically corrected, and the seven-parameter look-up table is searched, so that the quantitative inversion AOD value is obtained, and the temporal and spatial distribution characteristics of aerosols in the middle reaches of the Yangtze River urban agglomeration are obtained. The technology roadmap is shown in Figure 1.

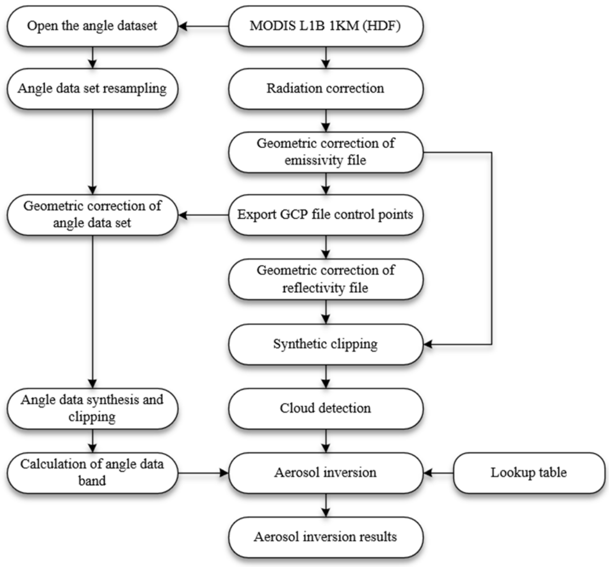

Fig. 1. The technology roadmap

3 Results and discussions

The MODIS data obtained from NASA are uniformly processed by the above research methods. The aerosol optical Depth is retrieved from May 2016 to May 2020. Because the retrieved area is urban agglomeration, which is affected by topography, topography, season and climate, the retrieval effect of aerosol is not ideal at some time points. Therefore, combining with the weather conditions of the day, choosing the inversion data of fine weather has a relatively good inversion effect and can achieve the expected results.

The AOD inversion by MODIS remote sensing adopts the method of establishing lookup table and interpolating AOD values, so the accuracy of AOD depends on the accuracy of establishing lookup table to a certain extent. In this paper, the plug-in is written in IDL language, and the 6S transmission model is called, which is divided into different surface types and observation bands. The atmospheric aerosol parameters are set in the model in advance, and the inversion results are obtained by using the observation parameters to calculate the radiation transmission.

It can be observed from the inversion results that the AOD value near the ground is between 0 and 3, and there are six levels of 0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-2.5, and 2.5-3.0 respectively. This level is set according to the actual inversion situation of urban agglomerations in the middle reaches of the Yangtze River and in combination with a large number of other research settings. Where 0 means that the air quality is extremely good without any aerosol particles, and 3 means that the air quality is extremely poor, and all the solar energy is absorbed or scattered by aerosol particles in the atmosphere.

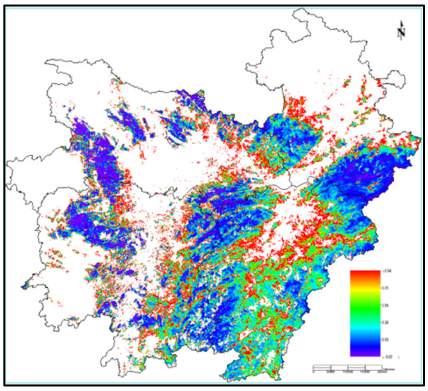

Fig. 2. Distribution of AOD in May 2016

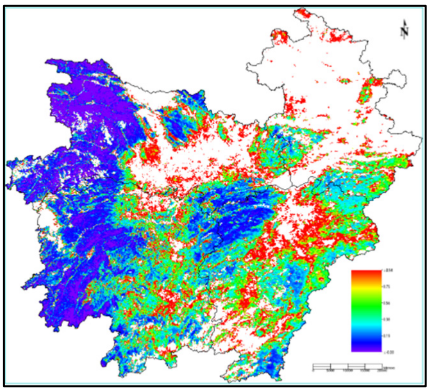

Fig. 3. Distribution of AOD in May 2017

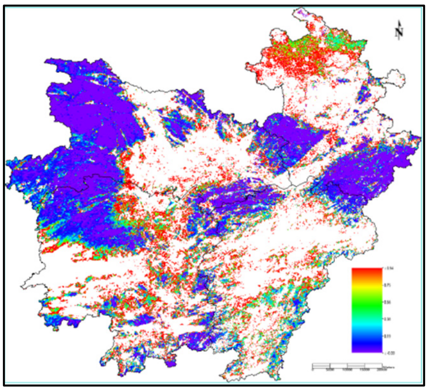

Fig.4. Distribution of AOD in May 2018

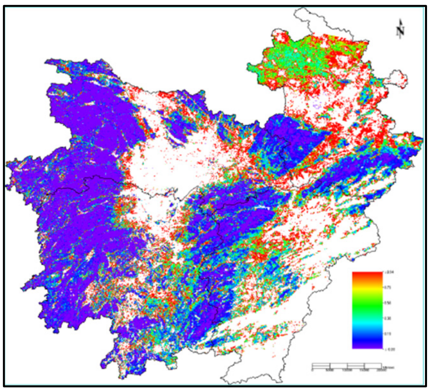

Fig. 5. Distribution of AOD in May 2019

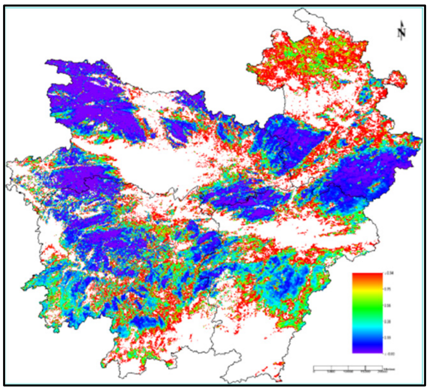

Fig. 6. Distribution of AOD in May 2020

The spatial distribution of AOD can be viewed from space. The AOD value near the ground are relatively high in the urban agglomeration areas in the middle reaches of the Yangtze River and in the northern urban areas of Anhui Province, which may be related to population movement and vegetation coverage. The AOD value near the ground in the south of Hubei Province and the middle of Jiangxi Province are relatively higher. From the AOD map of the middle reaches of the Yangtze River in recent five years, it can be seen that the areas near the surface with higher AOD value are located in the north and southeast areas with less vegetation coverage, while the areas with lower AOD values are located in the west and northwest areas with greater vegetation coverage.

By comparing the AOD distribution maps in different years, we can see the changes of time series. From 2016 to 2020, the AOD value on the near the surface continued to rise, and began to decrease slightly in 2018. In 2019, the AOD value on the near the surface reached the highest. According to the seasonal variation law of surface AOD value, the most obvious change with the season is the change of meteorological factors. It is speculated that the surface AOD value has a certain relationship with the changes of meteorological factors such as air pressure, air temperature and humidity, or that meteorological factors have a certain influence on the distribution of AOD.

4 Conclusions

In this paper, the temporal and spatial variation characteristics of aerosol optical Depth in urban agglomerations in the middle reaches of the Yangtze River from 2016 to 2020 were studied, and the following conclusions were drawn.

(1) The aerosol of urban agglomeration in the middle reaches of the Yangtze River is retrieved by using MODIS l 1b 1 km data from 2016 to 2020.

(2) Temporal and Spatial variation characteristics of aerosols in urban agglomerations in the middle reaches of the Yangtze River from 2016 to 2020.

The retrieved data are synthesized according to the annual maximum value, and then the annual average value is synthesized after the annual maximum value is obtained, so that the annual variation characteristics of aerosol in the middle reaches of the Yangtze River urban agglomeration from 2016 to 2020 are obtained.

In the whole thesis writing process, due to the limitations of data collection, experimental process and professional knowledge, while obtaining the above-mentioned learning achievements and conclusions, we are also aware of some deficiencies that need further research and improvement, as follows.

(1) In terms of inversion data, due to the influence of weather, images are often obscured by clouds, which may lead to errors in inversion results. If more effective data can be obtained in summer, it will be more beneficial to reflect the distribution characteristics and variation laws of aerosol optical Depth in urban agglomerations in the middle reaches of the Yangtze River.

(2) Due to the limitation of data collection and time, the research scope is relatively small. If the data collection is easy, we can choose a large area with more and more monitoring stations and many years of monitoring data to study. The accuracy of the relationship model between PM 2.5 concentration value and AOD value near the ground may be more accurate and persuasive.

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