

19. THE ANALYSIS OF TROPOSPHERIC NO₂ BETWEEN 2006 AND 2011 BASED ON SATELLITE MEASUREMENT ALL OVER CHINA

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The column amounts of tropospheric NO₂ from OMI/Aura of the whole year of 2006 and 2011 were applied to investigate the temporal and spatial variation characteristics of NO₂ pollution in the whole China from 2006 to 2011 preliminarily. Based on the results in the thesis, we can conclude that: In the year of 2011s, the NO₂ pollution in the mainland of China had become more serious than that in the year of 2006.

Key Words : OMI, NO₂, vertical column concentration, spatial variation, temporal variation.

1. INTRODUCTION

Nitrogen oxides are emitted by all combustion processes and play a key part in the photochemically induced catalytic production of ozone, which results in summer smog and has increased levels of tropospheric ozone globally. In addition, NO₂ also contributes to radiative forcing. Nitrogen dioxide (NO₂) as one of the most important species in tropospheric chemistry has attracted great attention of governments and scientists.

Nowadays, in China, the rapid increase in economic activities is accompanied by a strong increase of emissions of tropospheric pollutants, which contribute to extreme pressure on the atmosphere environment. Here we present the column amounts of tropospheric nitrogen dioxide, the mainly atmospheric pollutants, receiving from satellite instruments OMI of the years 2006 and 2011.

2. METHOD AND SOURCES OF DATA

OMI : The Dutch-Finnish OMI on NASA's EOS Aura satellite is a nadir-viewing imaging spectrograph measuring direct and atmosphere-backscattered sunlight in the ultraviolet-visible (UV-VIS) range from 270 to 500 nm. Compared with GOME and SCIAMACHY, the spectral sampling rate (resolution/sampling) of OMI is ~3, large enough to

avoid spectral undersampling or aliasing difficulties in the spectral fitting process, and takes one measurement of the solar irradiance per day.

3. RESULT AND DISCUSSION

(1)The applicability of satellite measurement

There are two methods to evaluate the amounts of nitrogen dioxide. One is evaluated by ground statistic data, the other is taken by the data from satellite measurement like that used in this thesis. **Fig.1** show the comparison between the data of ground NO₂ emission source and the column amount of tropospheric NO₂ from satellite instrument.

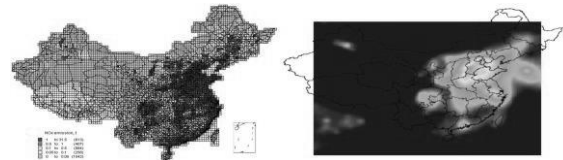


Fig.1 the picture made by the statistic data of ground emission and data from satellite instrument of NO₂

The remarkable correlation between the two measurements in the result picture can be found. The eastern part of China, the high populated and industrial area, has high tropospheric NO₂ columns amount. However, in the western China, as there is nearly no anthropogenic activity, a low tropospheric

NO₂ column has been found. Therefore, the method of satellite measurement is applicative to investigate the ground pollution condition of NO₂, what's more , the data of satellite measurement is much more easily to got compared with ground statistic data.

(2) Seasonal variation

Since the lifetime of NO_x is longer in winter, a NO₂ maximum is expected in winter. **Fig.2** show the four seasonal variation of tropospheric NO₂ all over china in the year of 2011. It can be seen that in the east of china, a seasonal NO₂ maximum is found according to the expected winter maximum. The daily pollution concentration will reach to $80 \times 10^{15} \text{ molec/cm}^2$ in some place of China. Mean value will reach over $100 \times 10^{15} \text{ molec/cm}^2$. The order of the vertical column density level of tropospheric NO₂ for the different seasons over west of china is: winter> autumn> spring>summer. (Second-quarter-spring: Mar.—Apr.—May; third-quarter-summer: Jun.—Jul—Aug; Forth-quarter-autumn: Sep.—Oct.—Nov; First-quarter-winter: Dec.—Jan.—Feb.)

(3) Yearly variation

Fig. 3 show the comparison of the column amount of tropospheric NO₂ all over china of the whole year between 2006 and 2011 year. It can be seen that the values of tropospheric NO₂ are on the increase not only on the especially in the highly developing megacity such as Beijing. Over the west of china, especially the distribution of Wulumuqi in Xinjiang, where there is a light increase in the amount of tropospheric NO₂, which is probably related to the highly economic development of Urumqi in the recent year. More and more factories are established there, therefore, the ground emission of NO₂ is increasing.

(4) The analysis of specific spatial distribution

And then we take five important city groups of china as research object. As is shown in **Fig.4**. Seen from a national scale, it shows an increasing trend in the NO₂ density all over China from year 2006 to 2011. However, as it is shown in the following pictures, the special distributions such as Yangtze River delta region and Chu Chiang Delta region reveal a slight decrease in the column amount of tropospheric NO₂ from year 2006 to 2011. In 2010, the Asian Games was held in Guangzhou, and in 2011 a world fair Shanghai Expo 2011 was held in Shanghai. A series of aggressive measurements taken by government are applied to restrict the pollution. Such as traffic control , the transformation of energy structure and so on.

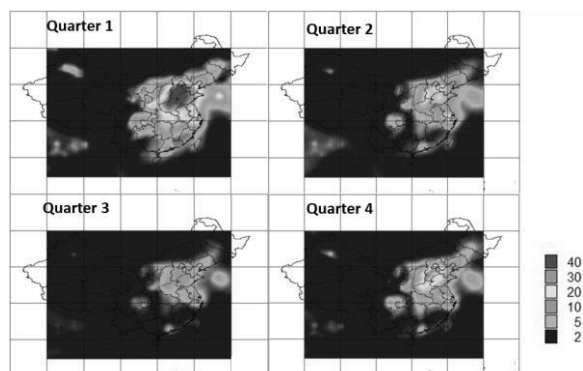


Fig.2 seasonal variations of tropospheric NO₂ all over china of 2011

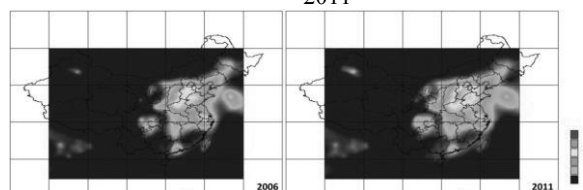


Fig.3 the comparison of tropospheric NO₂ all over china between 2006 and 2011

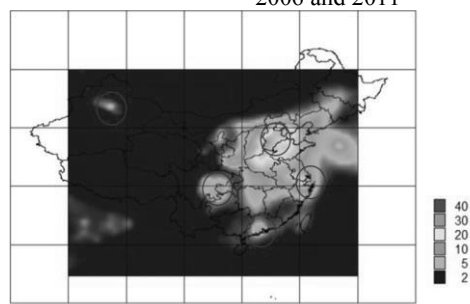
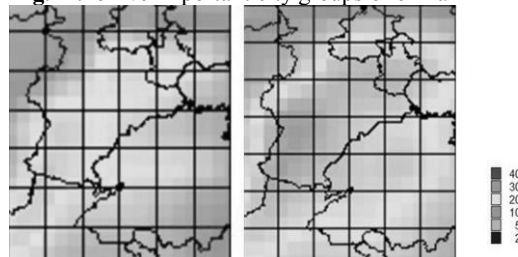
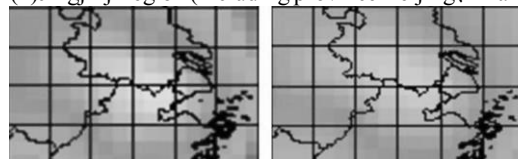


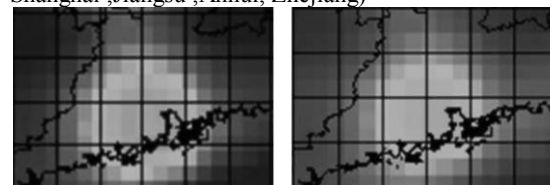
Fig.4 the five important city groups of china



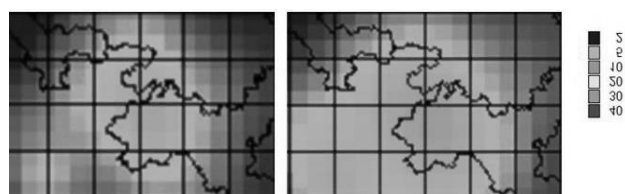
(1)Jingjinji region (including province Beijing、 Tianjing、 Hebei)



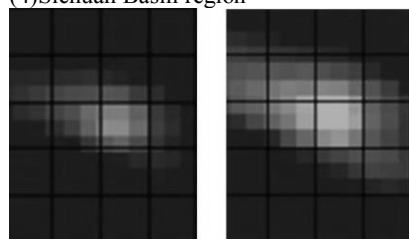
(2)Yangtze River delta region (including province of Shanghai ,Jiangsu ,Anhui, Zhejiang)



(3)Chu Chiang Delta region (including province of Guangdong ,Hongkong and Shenzhen)



(4) Sichuan Basin region



(5) the area of Urumqi in Xinjiang

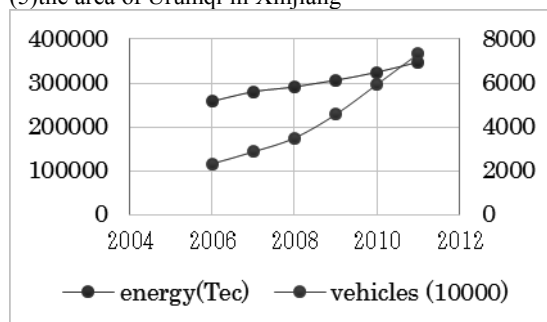


Fig.5 the factors of human activity attributing to the atmosphere pollution

(5) The effect of anthropogenic activity

Based on the data from statistical yearbook of china, Fig. 5 a clear increase in the energy consumption and the vehicles from 2006 to 2011 can be found. Although there is a series of aggressive measures were instituted to restrict vehicular traffic in big city like Beijing and Shanghai, the number of vehicles is getting quadruple compared with 2006. And the consumption amount of energy has also been doubled.

As is known to all, both the prominent anthropogenic activity and increasing vehicles exhausted gas could contribute to the observed increase of tropospheric NO₂. The figure shows a remarkable positive correlation between the ground emission and the column amount of tropospheric NO₂ all over china.

4. CONCLUSION

The columns amount of tropospheric NO₂

measured by OMI during 2006 and 2011 have been used for the study for trend, seasonal variation and sources analysis of tropospheric NO₂ over China.

The eastern part of China, especially in the northeast area, have a great population and intensive industries, therefore, there are a high emission of NO₂. However, in western China, as there is nearly no anthropogenic activity, a low tropospheric NO₂ column has been found. In the eastern part of China, winter maximum in seasonal cycle is found as expected due to the prominent anthropogenic activity and meteorological conditions.

When it comes to the trend of tropospheric NO₂, in the year of 2011s, the NO₂ pollution in the mainland of China had become more serious than that in the year of 2006; Furthermore, the vehicles population in Beijing shows remarkable positive relationship with its tropospheric NO₂ columns, which proves that prominent anthropogenic activity and increasing vehicles exhausted gas could contribute to the observed increase of tropospheric NO₂. However, aggressive measurements taken by government to control the NO₂ pollution is effective in some area like Chu Chiang Delta region.

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