An analysis on long-term changing trends and impacting factors of tropospheric ozone in North China based on satellite observations

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1.Introduction

- Tropospheric ozone is a kind of important pollutant and greenhouse gas, which is often closely related to human activities.
- As an important industrial and agricultural base as well as political and cultural center in China, North China (Fig 1) has undergone significant changes in atmospheric environment in the past more than 30 years. In the poster, the long-term changing trends and effects of main impacting factors of tropospheric ozone are studied.

Fig1. North China is located at 32-42°N and 110-120°E.

- A harmonized monthly mean tropospheric ozone dataset over North China from Jan 1979 to Dec 2013 is constructed and applied on the base of the NASA Langley Research Center tropospheric ozone data of Tropospheric Ozone Residual (TOR) from the TOMS/SBUV measurements [1] and similar dataset from the OMI/MLS measurements [2].
- SOLAR (solar radiation cycle), ENSO (El Nino-Southern Oscillation) and QBO (Quasi-Biennial Oscillation) are used as main impacting factors in the analysis[3].

2.Detection of tropospheric ozone changing trends

- Fig 2 shows the harmonized tropospheric ozone data series from Jan 1979 to Dec 2013 over North China.

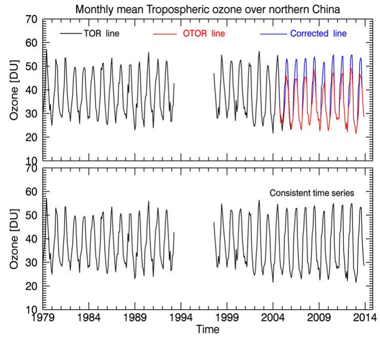

Fig2. The harmonized monthly mean tropospheric ozone time series from 1979 to 2013 and the original TOR datasets from TOMS/SBUV measurements (Jan 1979 to Dec 2005) and OMI/MLS measurements(Oct 2004 to Dec 2013).

- Fig 3 shows the long-term trends of tropospheric ozone for different reasons over North China. The results show that there is a significant increase with a rate of 1.28 DU/decade in summer, and a significant decrease trend of 1.46 DU/decade in winter. But for the other two seasons, there is a downward trend in fluctuations.

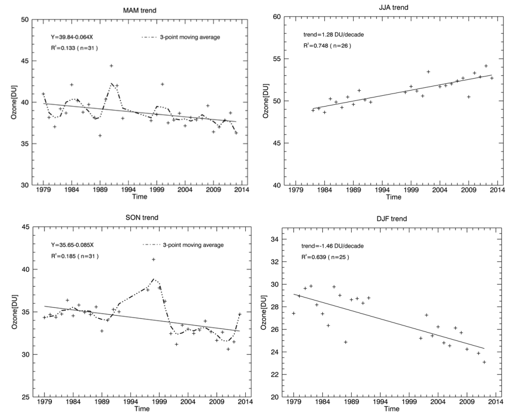

Fig3. The seasonal trends of tropospheric ozone over North China.

3.Evaluating main impacting factors on tropospheric ozone

- Fig 4 shows the multiple regression results for tropospheric ozone over North China.

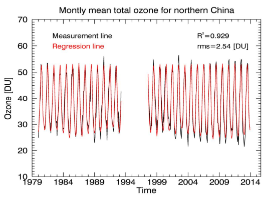

Fig4. Multiple regression results for tropospheric ozone over North China.

- Fig 5 shows effects of solar cycle on tropospheric ozone over North China.

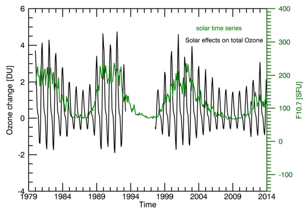

Fig5. Monthly effects of SOLAR on tropospheric ozone over North China.

- Fig 6 shows effects of ENSO on tropospheric ozone over North China.

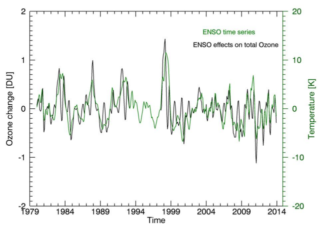

Fig6. Monthly effects of ENSO on tropospheric ozone over North China.

- Fig 7 shows effects of QBO on tropospheric ozone over North China.

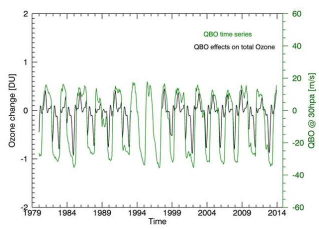

Fig7. Monthly effects of QBO on tropospheric ozone over North China.

4.Discussion

- Tropospheric ozone responses to solar flux changes at different regions are found to be quite different. Fig 8 shows solar regression coefficients as a function of month at 3 regions. The differences may imply the effect of background H_2O, NO_x and other atmospheric composition on tropospheric ozone chemistry. This deserves more observations and further study.

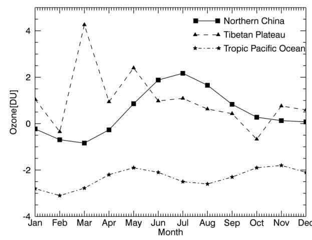

Fig8. Comparison of solar radiation effects on tropospheric ozone for North China, Tibetan Plateau (Huang et al., 2009) and Tropic Pacific Ocean (Chandra et al., 1999) .

5.Conclusions

- The harmonized monthly mean tropospheric ozone time series over North China from Jan 1979 to Dec 2013, on the base of TOR datasets from TOMS/SBUV and OMI/MLS, are constructed. With the data series, long-term changing trends and impacting factors are analyzed.
- The results show a significant increase trend with a rate of 1.28DU/decade and a significant decrease trend with a rate of 1.46DU/decade in North China. In the other two seasons, there is a similar downward trend in fluctuation.
- Multiple regression results show that the range of monthly effects of SOLAR on tropospheric ozone over North China is about -1.5~ 4.5DU from solar maximum to minimum. Monthly effects of ENSO on tropospheric ozone are about ±1DU, and effects of QBO on tropospheric ozone are about -1~ 0.5DU.
- Difference in response of tropospheric ozone to change of solar radiation is noticeable for North China, Tibetan Plateau and tropical Pacific Ocean. This deserves more observations and further study.

1. Fishman, J., A.E.Wozniak, J.K.Creilson, 2003, Global distribution of tropospheric ozone from satellite measurements using the empirically corrected tropospheric ozone residual technique: identification of the regional aspects of air pollution, Atmos.Chem.Phys., 3: 893-907,doi: 10.5194/acp-3-893-2003.
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