Weekly Cycle of PM10 in Eastern China: the seasonal patterns and possible effect on radiation

Wang Wenshan and Gong Daoyi

State Key Lab. of Earth Surface Process and Resource Ecology, Beijing Normal Univ., Beijing, China

1 Introduction

Weekly is an exclusive and steady time period of human activities. And the transmission rate of aerosol is limited so that the weekly change of the concentration in the air will reflect the change of the source rate. In the previous studies, data derived from satellites were analyzed (S. Beirle, 2003; X. Xia, 2008). They all found clear weekly cycles of NO or AOD over North America and Europe but not over Eastern China. In this study, we intend to use the ground-based data to detect the weekly signals of PM10; and the possible sources and effects of these particles on radiation will also be discussed.

2 Data

PM10: Calculated from **A**ir **P**ollutant **I**ndex
- Air pollution index for major pollutant (API) from MEP (1: SO2; 2: NO2; **3. PM10; 4: None**)
- Cross out the stations with more than 30 days missing in one season
- 34 stations: June, 2001 – Dec. 2009
  34+38=72 stations: June, 2004 – Dec. 2009
- Odds (outside 3 std.); Anomaly: every month

Socioeconomic data from Statistical Yearbook
Meteorological and **Radiation data** from CMA

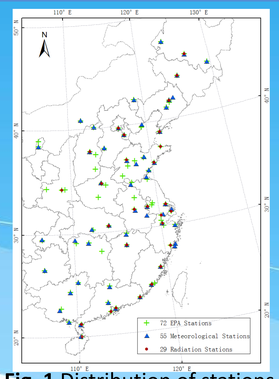


Fig. 1 Distribution of stations

3 Weekly Cycle: PM10

There is a significant annual weekly cycle of PM10, which is confirmed by T-test and Kruskal-Wallis Test; however the seasonal results are not that obvious.

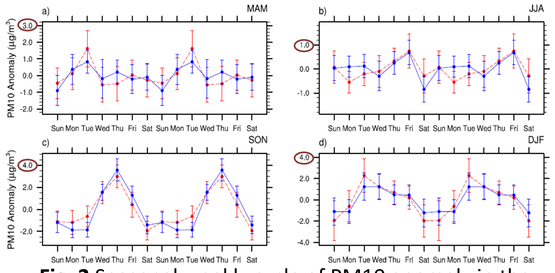


Fig. 2 Seasonal weekly cycle of PM10 anomaly in the cities of Eastern China: a) MAM; b) JJA; c) SON; d) DJF. (Red line: 34-station avg. from June, 2001-Dec. 2009 ; Blue line:54-station avg. from June, 2004-Dec. 2009; Error bars are the 97.5% confidence interval of the avg.; and the two weeks are sharing the same set of data)

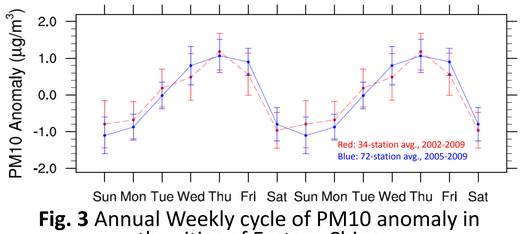


Fig. 3 Annual Weekly cycle of PM10 anomaly in the cities of Eastern China

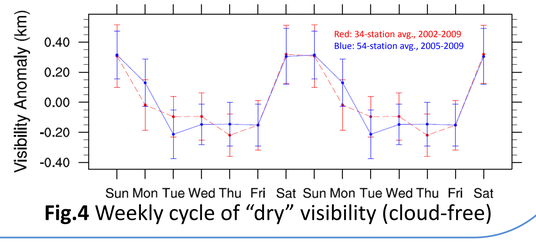


Fig.4 Weekly cycle of "dry" visibility (cloud-free)

4 Spatial Distribution of WI

Weekend Index = avg.(Wed., Thu., Fri.) – avg.(Sat., Sun., Mon.)
- T-Test: 54 of 72 stations are significant
- Dark red dots with large positive WI spreads in the eastern coastal region
- Blue dots: southern coastal region
- Large dots with high average PM10 concentration: Northern China

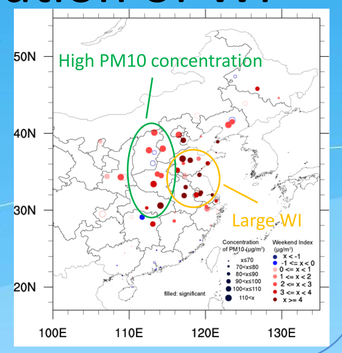
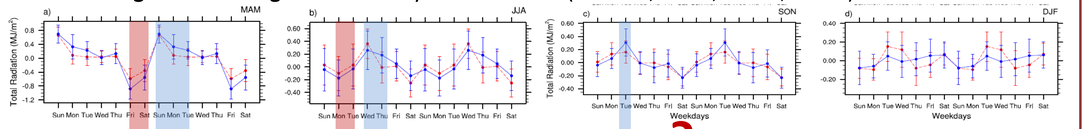


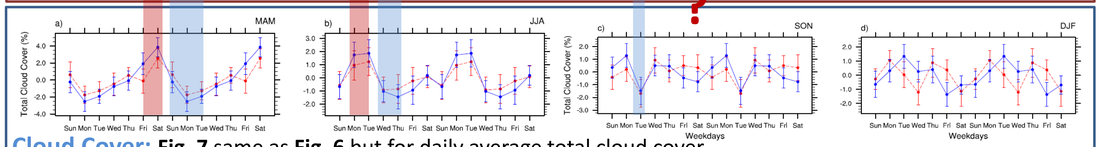
Fig. 5 Distribution of annual Weekend Index of 54 stations with significant difference between the avg. of weekdays and weekends

5 Effects on Radiation

Radiation: **Fig. 6** same as **Fig. 2** but for daily total radiation (a: MAM; b: JJA; c:SON; d: DJF)



Cloud Cover: **Fig. 7** same as **Fig. 6** but for daily average total cloud cover



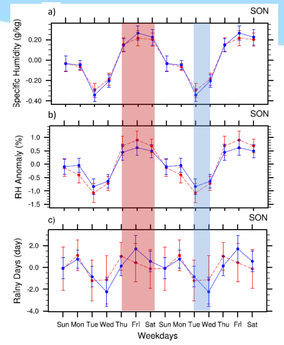


Fig. 8 Weekly cycle of a) Specific Humidity; b) RH; c) Rainy Days Anomaly in autumn

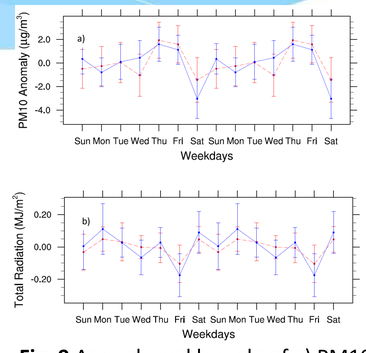


Fig. 9 Annual weekly cycle of a) PM10 Concentration; b) Total Radiation Anomaly under cloud-free skies

The Weekly Cycle of radiation: max. on weekdays; min. on weekends. Along with the cycle of PM10 but against the cycle of cloud cover in MAM and JJA. In autumn with the least number of cloudy days, however, the max. of q, RH and rainy days are on Weekends. Cloudy days removed, the annual weekly cycle of PM10 go against radiation.

6 Possible Source of PM10

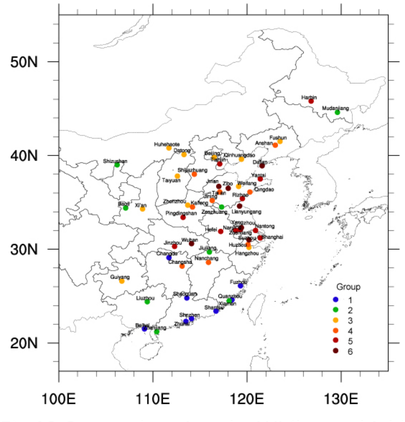


Fig.10 Grouped stations by WI (low to high)

Table 1 Results of Kruskal-Wallis Test on socioeconomic data (red tick: significant different; green cross: not significant)

Population		✗
Civil Vehicles	Total	✗
	Passenger	Large
	✓	✗
	Trucks	Heavy
	✓	✗
GDP	Industry	✗
✓	Construction	✓

Table 2 Socioeconomic data of the 6 groups (red figures: significant from Group 2 tested by K-W Test)

Group	1	2	3	4	5	6
Passenger Vehicles (10 thousand)	22.70	7.54	57.95	15.77	29.92	28.33
Trucks (10 thousand)	7.13	3.49	9.19	4.24	6.83	8.23
GDP (0.1 billion)	1651.42	652.61	2378.31	1745.86	2914.72	2603.28
Construction (0.1 billion)	60.35	45.02	132.80	110.60	176.08	152.65

- Divide 54 stations into 6 groups by WI (low to high)
- Differences of Socioeconomic data and rainy days among groups: K-W Test
- Group 1 (with the smallest WI):most frequency precipitation; Group 2: the least developed area.
- Possible source: Vehicles and construction

7 Summary

- The Weekly Cycle of PM10 in the cities of Eastern China does exist
- Northern China and the middle and lower reaches of Yangtze River suffer the largest Weekend Index
- Semi-direct effect of aerosol may play an important role in Eastern China
- The Weekend Index is probably related to the number of passenger vehicles and trucks, and the product of construction

Contact: Wang Wenshan (mswangws@gmail.com)