Impacts of large-scale circulation patterns on winter haze over China: from extreme events to interannual variability

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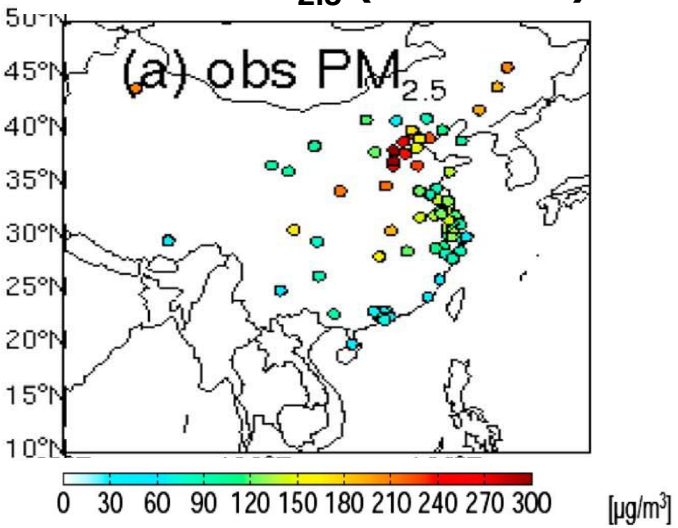
Severe haze in Jan 2013 and the anomalous large-scale pattern

Surface $PM_{2.5}$ (Jan 2013)



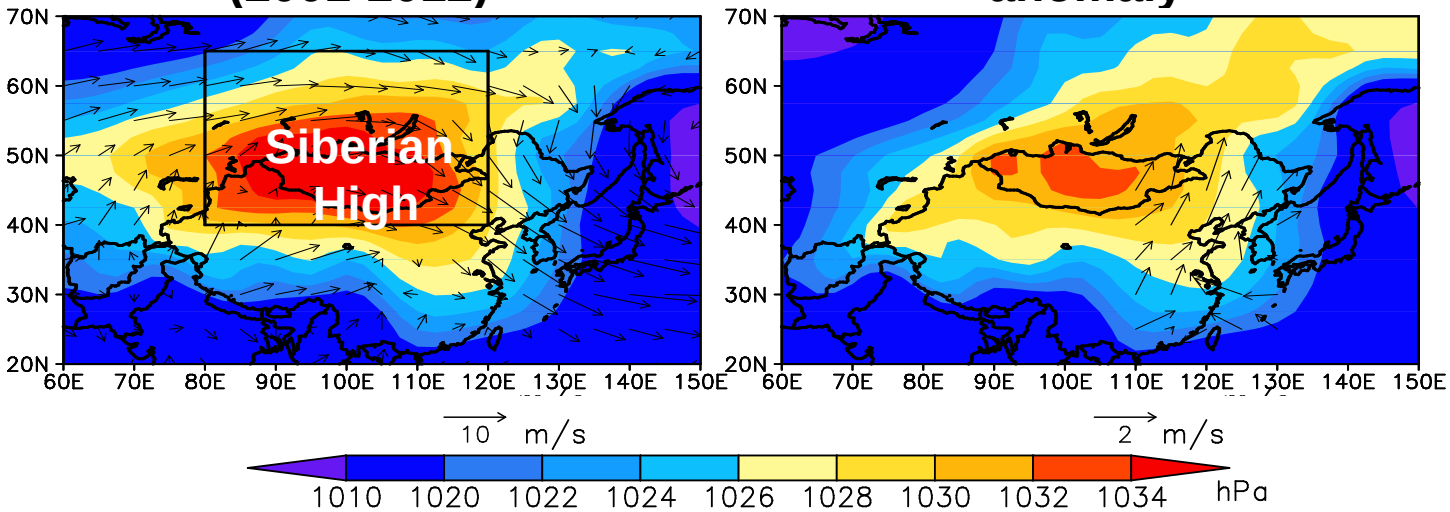
The change of the large-scale circulation pattern in Jan 2013.

The connections between wintertime PM and the large-scale circulation patterns on a longer time-scale.

Wang Y et al., JGR, 2014

Jan SLP and 850hPa winds (2001-2012)

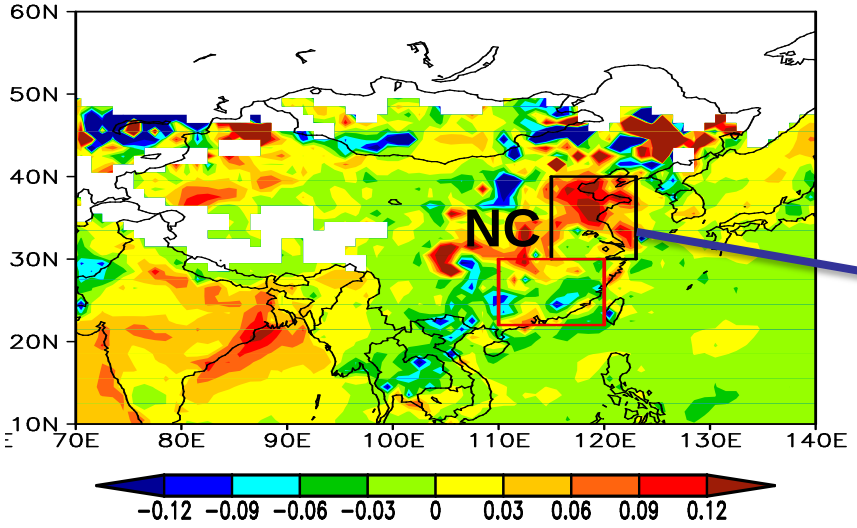
Jan 2013 SLP and 850hPa wind anomaly



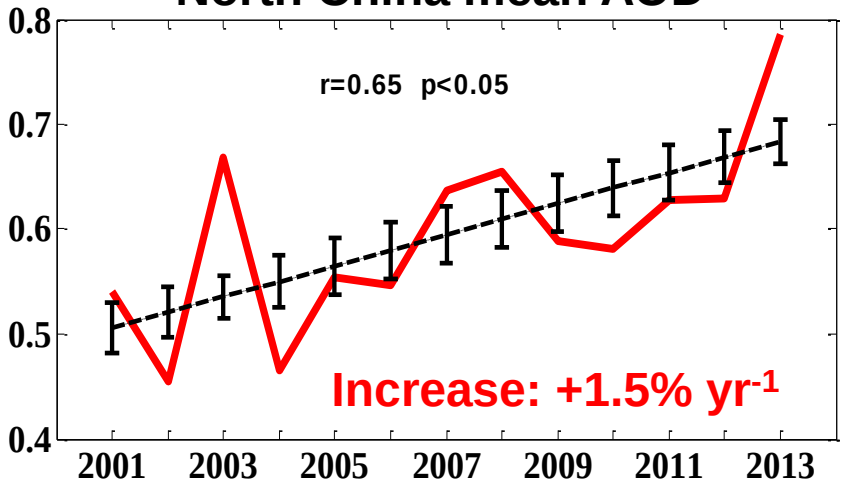
Winter PM in China and Siberian High variability

Aerosol Optical Depth (AOD) from MODIS (DJF, 2001-2013)

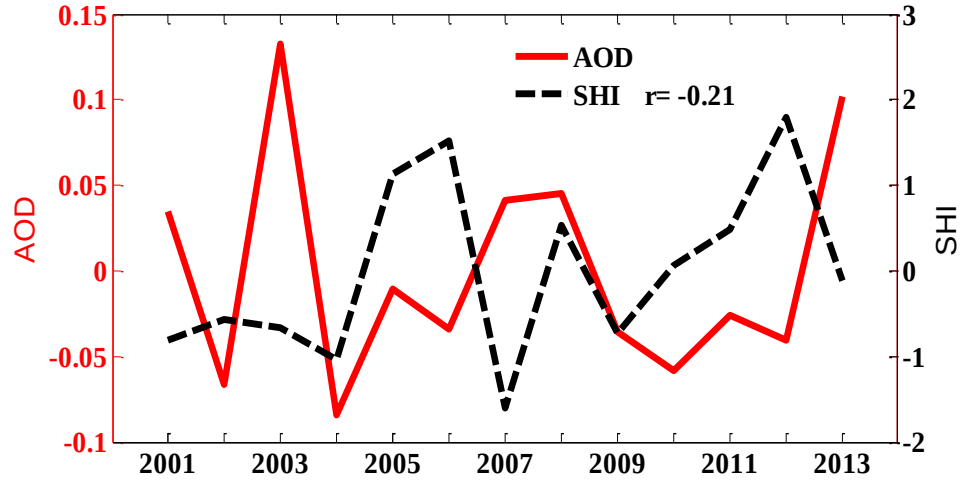
2007-2013 mean vs 2001-2006 mean



North China mean AOD

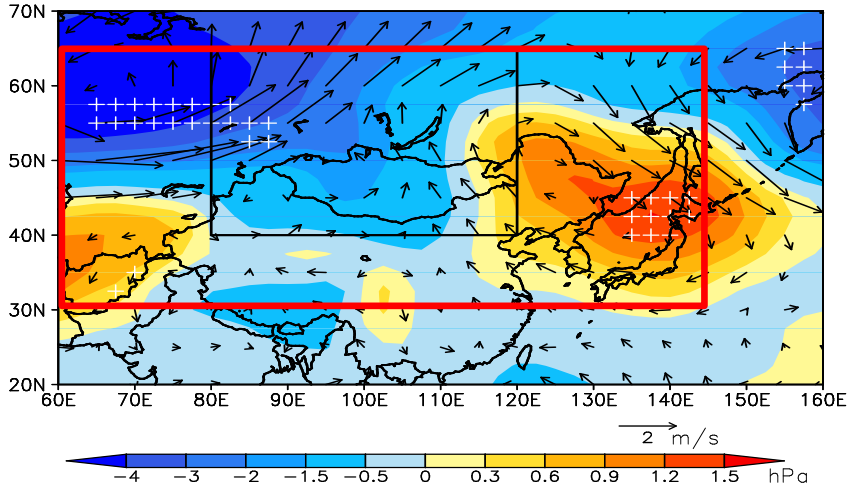


Siberian High Index (SHI): conventionally defined by its center intensity



A new index: Siberian High Position Index (SHPI)

ΔSLP and 850 hPa winds (high-AOD yr minus low-AOD yr)

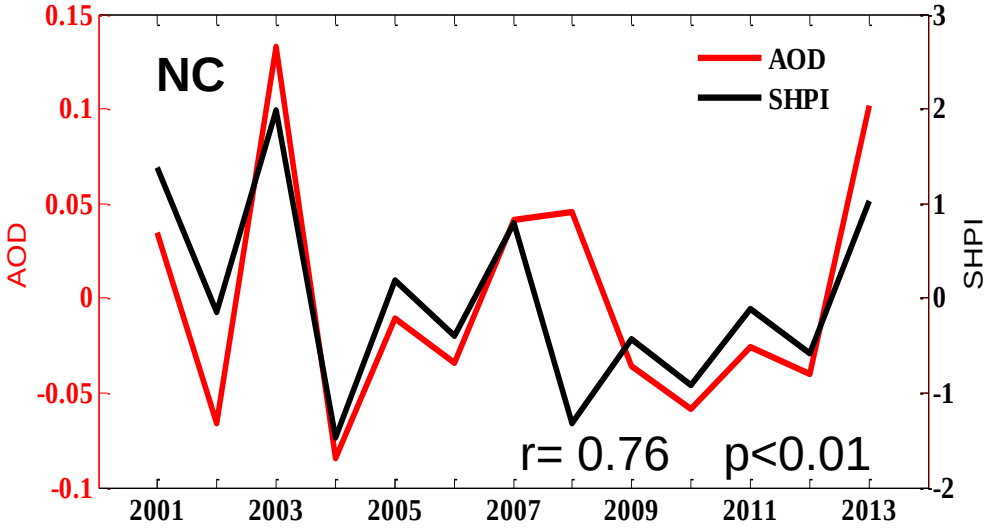


Siberian High Position Index (SHPI): weighted mean longitude

$$SHPI = \frac{\sum (P_i \times L_i)}{\sum P_i}$$

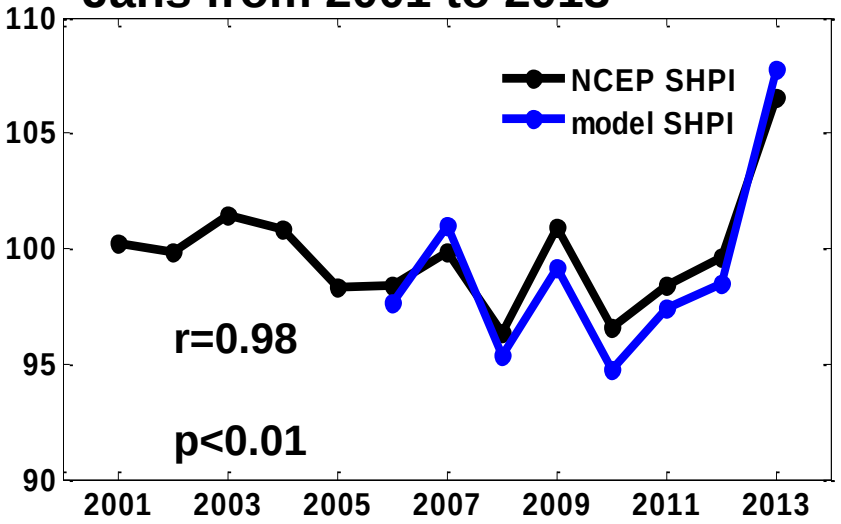
where L_i is the longitude of any eligible grid i within the 1023 hPa isobar and the definition domain; P_i is the SLP of the corresponding grid.

Siberian High Position Index (SHPI) and detrended NC AOD

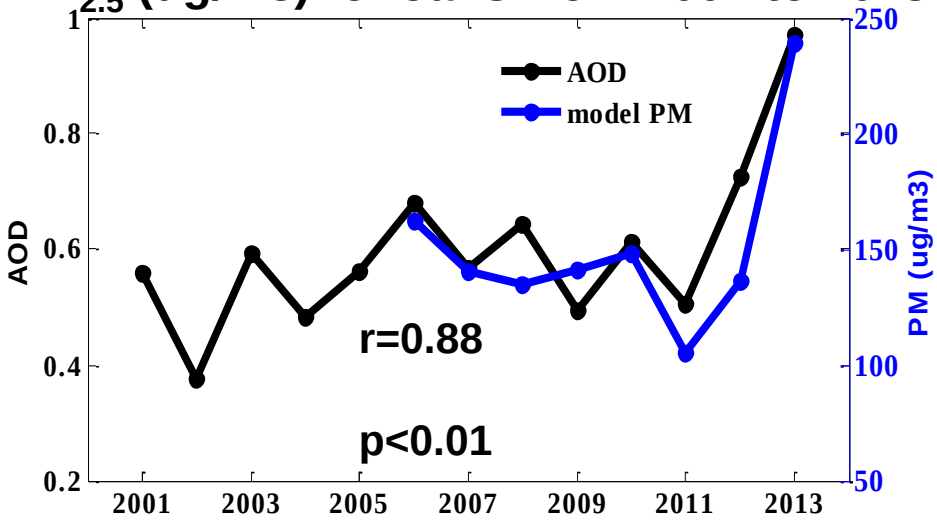


Simulated SHPI and $PM_{2.5}$ in GEOS-Chem

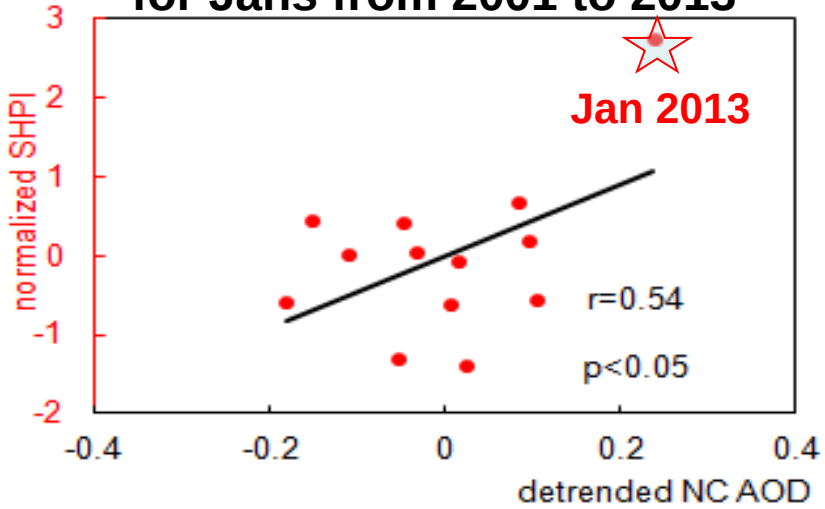
Model SHPI and NCEP SHPI for Jans from 2001 to 2013



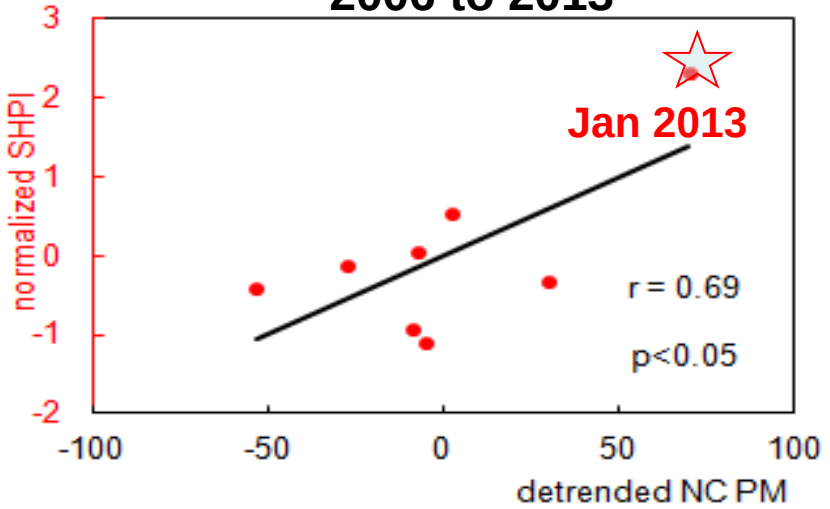
MODIS NC AOD and model NC surface $PM_{2.5}$ (ug/m3) for Jans from 2001 to 2013



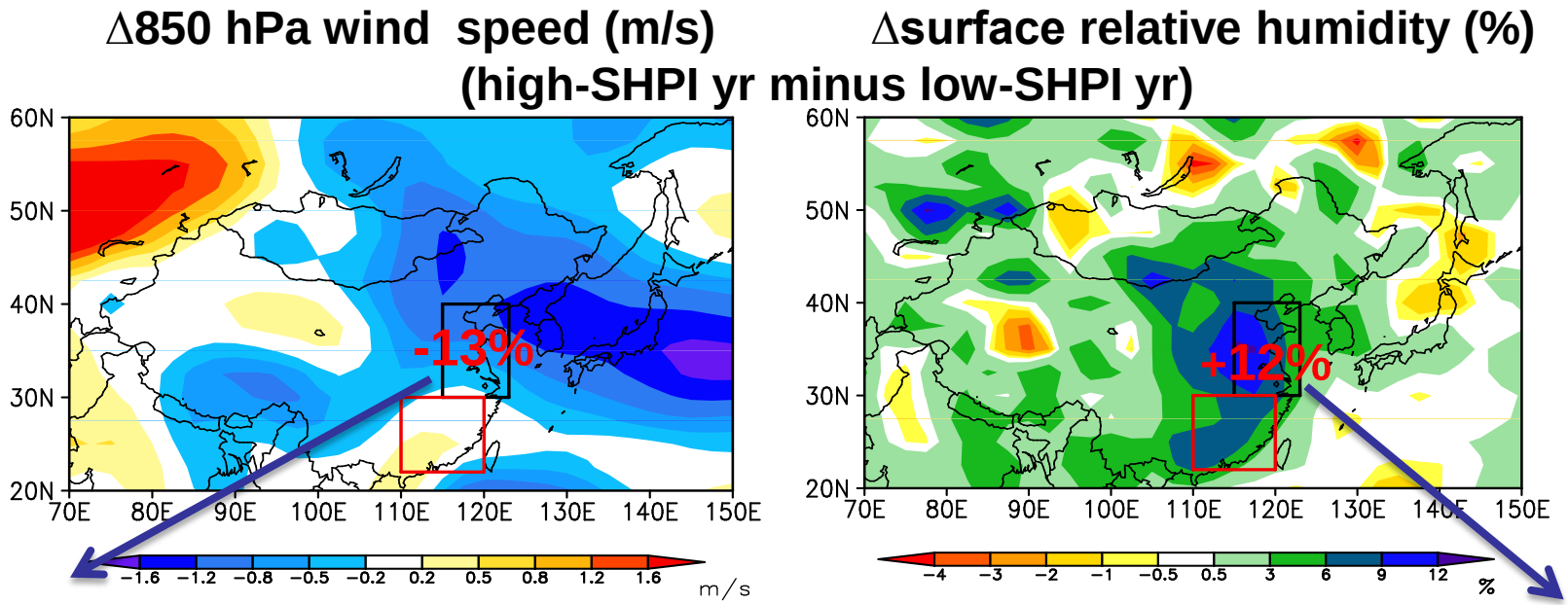
NCEP SHPI and MODIS NC AOD for Jans from 2001 to 2013



Model SHPI and NC PM for Jans from 2006 to 2013



Mechanism (NCEP from 1982 to 2011)



pollution accumulation

hygroscopic growth

Meteorological conditions over NC

	Surface	850 hPa wind speed		700 hPa wind speed		500 hPa wind speed	
	RH	U	V	U	V	U	V
1982-2011 mean	69.56	4.18	-3.06	10.94	-3.22	23.30	-3.17
High-SHPI mean	74.09	3.83	-2.67	10.39	-2.66	21.58	-2.33
Low-SHPI mean	66.00	4.26	-3.18	11.23	-3.17	24.24	-2.94

Summary

- The eastward extension of the Siberian High characterizes the anomalous large-scale circulation in January 2013, which is partly responsible for the severe haze in China of that month.
- SHPI explains 58% of the interannual variance in AOD over North China. Some high-PM events correspond well with high-SHPI both in observation and in the model simulation.
- The enhanced RH and the suppressed prevailing winds over NC in high-SHPI winters lead to enhanced hygroscopic growth and pollution accumulation.