Trend and variability of wintertime visibility in the North China Plain

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Abstract

The North China Plain (NCP) has suffered frequent severe low visibility events in recent winters. Here we diagnose the trend and variability of wintertime visibility (VSB) clearing events in the North China Plain (NCP) during 1973-2014, with the goal of understanding its possible causes. We found that for most NCP sites, the number of clearing events has decreased over the past 40 years, driven by decreasing number of synoptic-scale weather events. For three sites in the center of the NCP, the poor visibility in recent years is driven by increased pollution in surrounding area.

➢ Data and Methods

- Meteorological data from the National Climatic Data Center (NCDC) for 11 stations in the NCP for 1973-2014
- We analyzed detrended wintertime VSB from November to March.

➢ Questions

- How has the VSB clearing events changed over the last 40 years?
- The relationship between the VSB and the relative humidity
- The relationship between the VSB and the wind

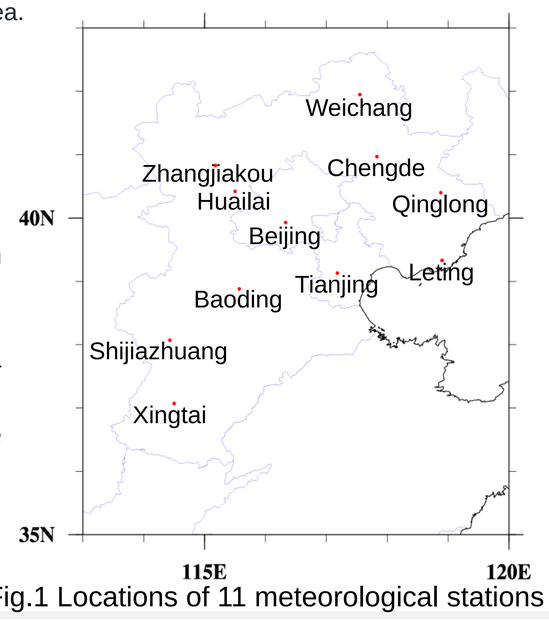
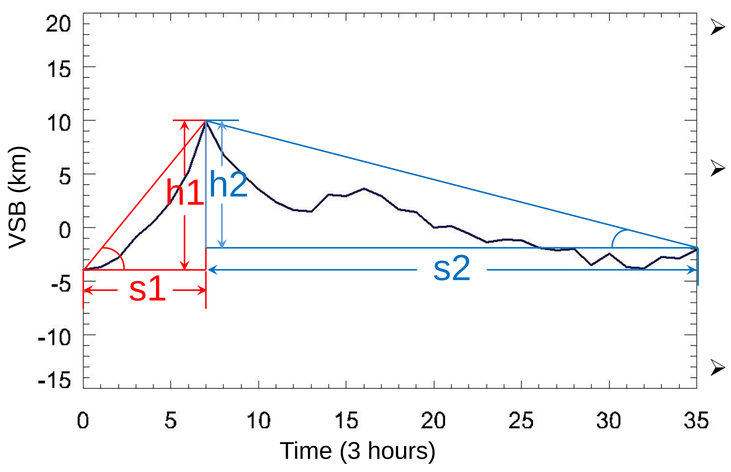


Fig.1 Locations of 11 meteorological stations

Analysis

Definition of a VSB clearing event

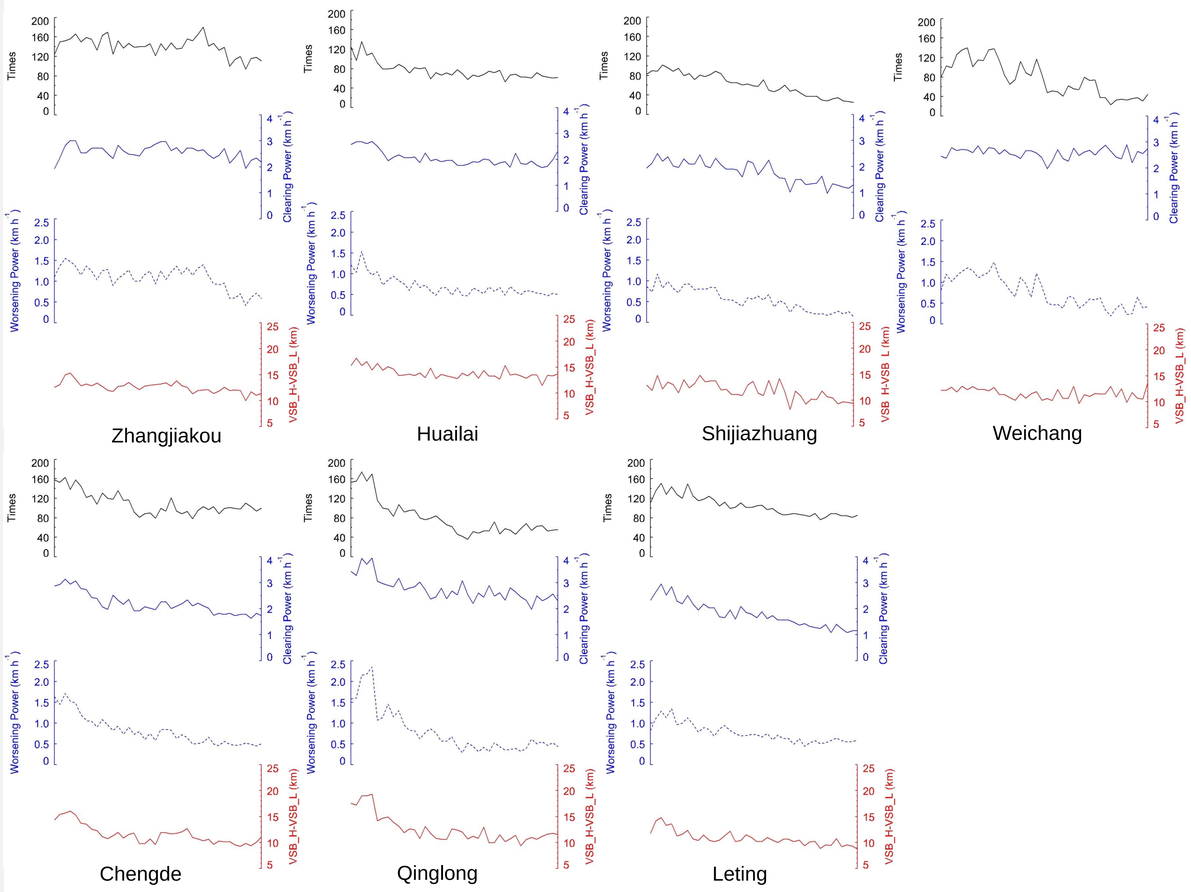


- ➢ The "clearing": when the increased VSB is no less than 6km, the slope ($\frac{h1}{s1}$ as shown left) of this process is defined the VSB's clearing power
- ➢ The "worsening": begin with the end of the prior "clearing" and end with the begin of the next "clearing" and the slope ($\frac{h2}{s2}$ as shown left) of this process is defined the VSB's worsening power
- ➢ The number of the clearing process and worsening process is defined Times.

VSB clearing events in the North China Plain during 1973-2014

Except for Xingtai, this study researched 10 sites as above definition. Based on significant analysis, the results were divided into 2 groups, number of clearing events decreased and number of clearing events showed no trend.

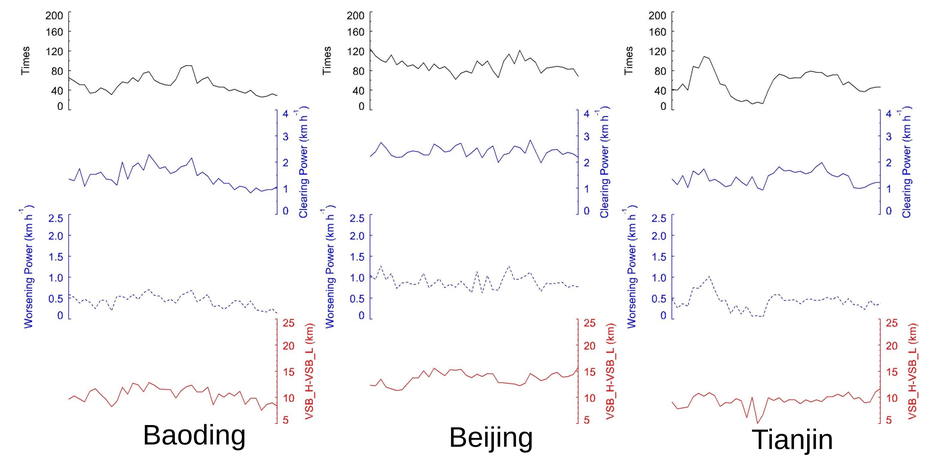
Group 1: Number of clearing events decreased



- ➢ For seven sites in the NCP, the number of VSB clearing events in winter decreased significantly over the past 40 years
- ➢ Except for Weichang, the differences between highest and lowest visibility (VSB_H-VSB_L in picture, h1 as defined) at these sites have decreased significantly
- ➢ The decreasing number of VSB clearing events is likely driven by a decrease in synoptic-scale weather system passage.
- ➢ Except for Weichang, the decreased differences between highest and lowest visibility at these sites significantly showed a decreased strength of synoptic-scale weather system

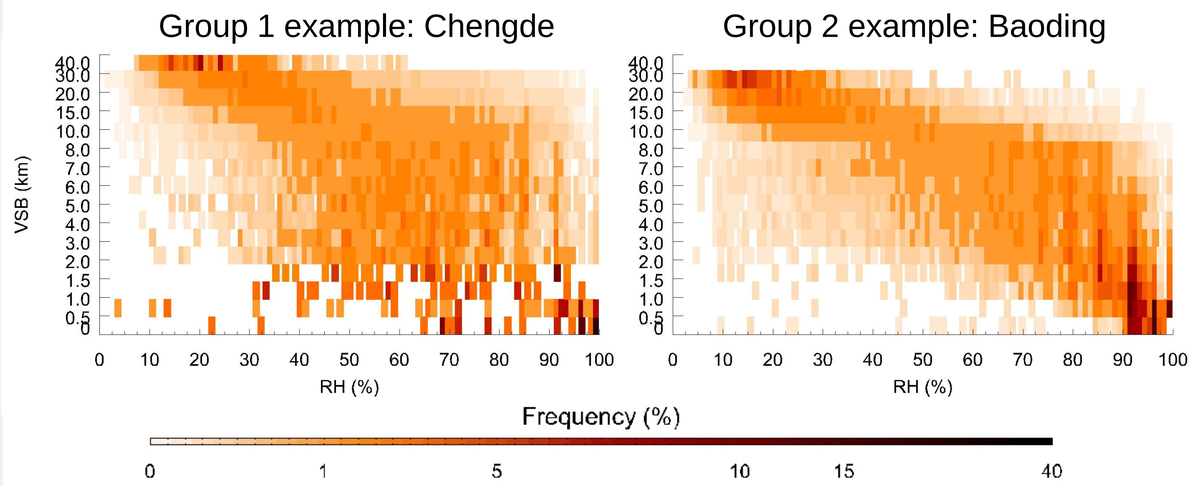
Analysis

Group 2: Number of clearing events showed no trend



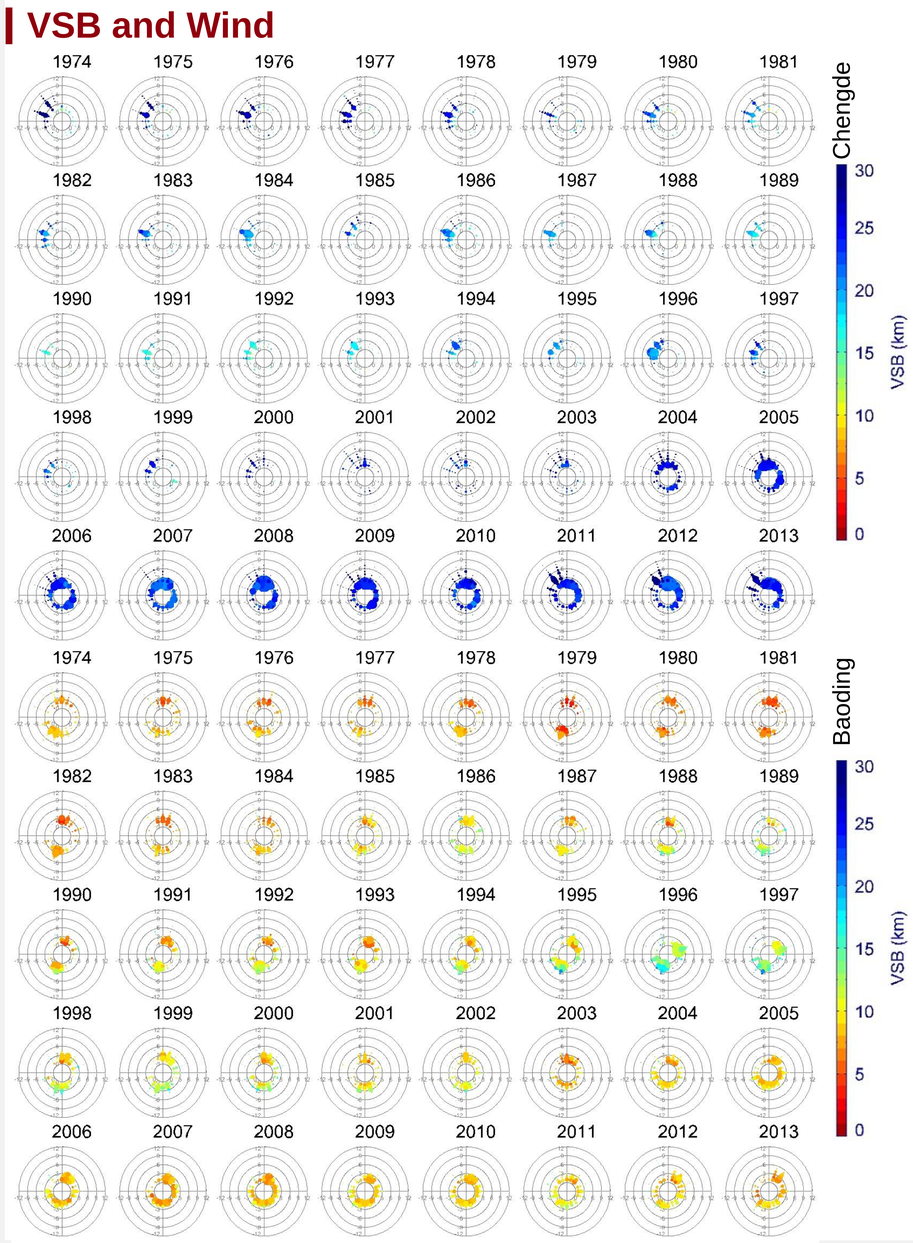
- ➢ For Beijing, Tianjin, and Boading, the number of VSB clearing events showed no significant trend.
- ➢ For these three sites, the differences between highest and lowest visibility showed no significant trend.

VSB and RH



- ➢ Group 1: VSB and RH are negatively correlated for VSB > 10km, but for VSB < 10km this correlation is weak
- ➢ Group 2: VSB and RH are negatively correlated for all VSB

VSB and Wind



- ➢ Radius: wind speed
- ➢ Angle: wind direction
- ➢ Color: VSB range
- ➢ Circle size: wind frequency

Group 1:

- ➢ The local wind pattern changed from strong northwesterly to weaker winds with no dominant directions
- ➢ Consistent with a weakening of synoptic-scale weather processes

Group 2:

- ➢ No apparent wind pattern changes over the past 40 years
- ➢ Winds are relatively weaker, such that air quality in surrounding area has large impacts
- ➢ Air quality in surrounding area improved in the late 1990s, but degraded from the early 2000 to the present

Conclusions

- ➢ The numbers of the VSB clearing events have decreased over the past 40 years over most of the NCP, due to a decrease in synoptic-scale weather system passages
- ➢ For three sites in the central NCP, the numbers of VSB clearing events showed no significant trend. The poor visibility in recent years is driven by increased pollution in surrounding area.