1. **Quantity controls**

To improve the accuracy and continuity of data we used, a series of strict quality control (HUSAR et al 2000, Lin et al 2014, Lin et al 2014, Guo et al 2017) were implemented.

Selection criteria for meteorological data included the following: (1) a month was considered to be sufficient if there were 6 or fewer missing days within the month; (2) a year was considered to be complete if all months were sufficient according to (1); (3) a station was eliminated when the variation in longitude or latitude extended beyond 50 km, or the variation in height above sea level extended beyond 100 m; (4) to get continuous records, the average of adjacent stations within a 25 km radius was used to
replace missing data.

Visibility data are selected as follows: (1) only visibility data at 14:00, Beijing time are selected; (2) a station should be removed if the median value passes 11 km but the maximum does not exceed 12 km; (3) a station should be removed if there are fewer than 5 distinct values; (4) a station should be removed if the missing data exceed 1% of the total data; (5) to get continuous records, the average of adjacent stations within a 25 km radius was used to replace missing data.

1. Daily weather phenomena records used
   Lacking weather phenomena records from the National Meteorological Information Center, we choose data recorded by weather websites, their addresses are as following:
   (1) http://www.tianqihoubao.com/lishi/index.htm,
   (2) http://tianqi.2345.cn/wea_history/71141.htm,
   (3) https://www.baidutianqi.com/history/,
   (4) http://www.tianqishi.com/lishi/.

   After comparing data from 4 different websites, we find consistent records results, proving the reliability to some extent.

2. Methodology
   The nonparametric Mann-Kendall (MK) test has been widely used to assess abrupt change. Previous studies find the existence of a positive serial correlation will increase the possibility of rejecting the null hypothesis while a negative serial correlation will reject (Yue et al 2002, Yue et al 2002, Novotny et al 2007, Villarini et al 2011, Ouarda et al 2019). Therefore, to limit the influence of serial correlation on the MK test, a popularly revised Mann-Kendall test has been used (Yue et al 2004, Zhang et al 2006, Ouarda et al 2019), the main steps are shown as the following:
   (1) First, the serial correlation analysis method in Haan (2002) is used, the equation is:
\[
\rho_k = \frac{\text{Cov}(x_t, x_{t+k})}{\text{Var}(x_t)} = \frac{1}{n-k} \frac{\sum_{t=1}^{n-k} (x_t - \bar{x}_t)(x_{t+k} - \bar{x}_t)}{\frac{1}{n} \sum_{t=1}^{n} (x_t - \bar{x}_t)^2}
\]

where \( X_t \) (t=1, 2, ...) is the tested time series, \( X_{t+k} \) is the same time series with a time lag of \( k \), and \( \bar{X}_t \) is the mean of the time series. If \( \rho_k \) falls between the 95% confidence level lines, it means the tested series are independent at the 95% confidence level.

The average annual CBDI time series were tested and the result is shown below in Fig. S1. We notice that almost all series are statistically independent, except data at lag2, where we can see an obvious positive correlation.

**Figure 1.** The first-order autocorrelations of average annual CBDI during 1980-2014. The 95% confidence bounds are plotted in blue, a number outside the blue lines indicates a significant trend.

1. The effective sample size \( n^* \) has been proposed to modify the variance \( V(S) \) to \( V^*(S) \) (Bayley et al 1946)

\[
n^*_t = \frac{n}{1 + 2 \sum_{k=1}^{n-1} (1 - \frac{k}{n}) \rho_k}
\]

\[
V^*(S) = V(S) \cdot \frac{n}{n^*}
\]

where \( V(S) \) is the original MK variance and \( n \) is the actual size of the sample.

2. Then, the \( V^*(S) \) has been put into the traditional MK test. The final result indicates that no significant trend exists in the time series (not shown), therefore the result we used was sufficient to effectively detect the effect of the serial
correlation on the MK test.

3. **Summary Statistics for Annual and Seasonally Averaged CBID**

Table S1. Summary Statistics for Annual and Seasonally Averaged CBID

|                   | annual | spring | summer | autumn | winter |
|-------------------|--------|--------|--------|--------|--------|
| mean              | 161.1  | 39.3   | 29     | 45.5   | 46.1   |
| Trend(days/decade)| 1.6*   | 1.4    | 0.3    | -0.3   | 0.2    |
| R²                | 0.12   | 0.38   | 0.036  | 0.02   | 0.005  |
| SD                | 4.7    | 2.4    | 1.8    | 1.9    | 2.38   |

SD, standard deviation; the trends are for 1980–2014
R², R-square coefficient; *, pass the 95% significance of the level

4. **EOF pattern of the CBDI during 1980-2014**

![Figure S2](image)

Figure S2. The spatial pattern of the EOF1 (a), EOF2 (c) mode of the CBDI, and the time series of the first principal (PC1) (c) and PC2 (d) component over China from 1980 to 2014.
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