Attributing wind speed declination in China for the last 50 years

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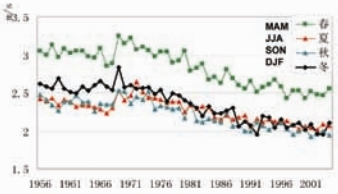
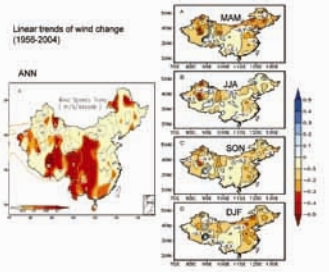
Outline

1 Observed wind speed change

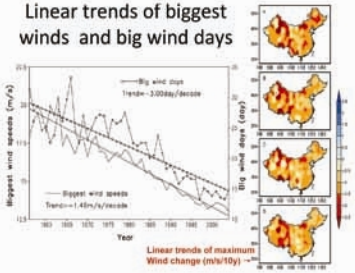
- Annual and seasonal changes of wind speeds
- Maximum wind speed change
- Strong wind days change

Observed seasonal changes of wind speeds in China for 1956-2004





Linear trends of biggest winds and big wind days



2 Attributing wind changes

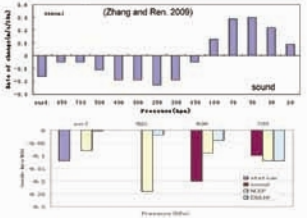
(1) Natural change: monsoon, circulation

(2) Land-use change: Urbanization, environmental change

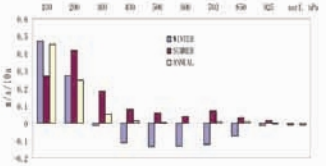
(3) Anthropogenic emission (global warming)

(4) Methods: observed diagnostic, climate modeling

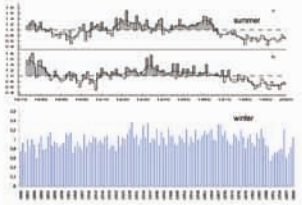
Linear trends of wind at troposphere and stratosphere in China



Linear trends in troposphere and stratosphere of China as simulated by the AR4 models

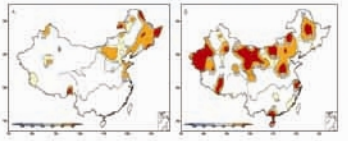


East Asian monsoon (Guo et al., 2004)
(winter and summer monsoon reduced)



Correlation coefficients between strong wind days and cold wave days(A), strong wind days and dust storm days (B)

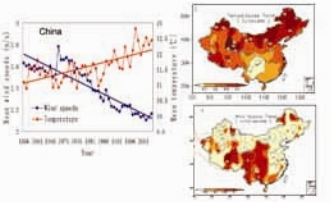
Yellow and red colors are positive correlations at 95 and 99% levels



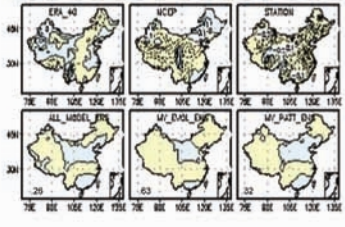
Decreasing trends of strong winds days, cold wave days and dust storms

Urbanization (contribution by about 20%)

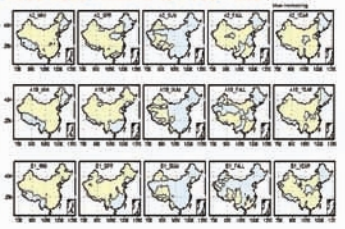
Global warming



Distributions of linear trends of wind change as simulated by all 20C3M and several better models



AR4 GCMs projection of wind change for 2080-2099 relative to 1980-1999



3 Conclusions and discussions

As analyzed by the observed stations' wind for 1956-2004, the annual and seasonal mean wind speed, days of strong wind and maximum wind all show the declining trends over the broad areas of China. Based on the observed stations' data in China, the annual mean wind speeds have been reduced by -0.124m/s per decade. It is -0.123 and -0.046 m/s per decade as calculated by the NCEP/NCAR and ERA40 reanalysis data in China, respectively. The investigation found that the annual and seasonal strong wind reduced obviously in China for the last 50 years that are the major reason of the mean wind reduced. Attribution on strong and mean wind weakened are analyzed by using both observed data and the global and regional climate models that are twenty global climate models (among them, 19 models from AR4-20C3M and one from AR5) and three regional climate models over China as well as their ensembles. The following conclusions are got:

(1)Both global climate models and regional climate models have the certain capabilities to simulate the patterns of the annual and seasonal mean wind speeds in China, especially for the ensembles and regional models, to compare with the observations. But most global and regional climate models fail to simulate the obviously decreased trend of wind speeds as pointed by the observed data. Only a few of them simulate the slightly decreasing trends of annual (or seasonal) wind speed changes in China by about -0.01 ~ -0.02 m/s per decade (only one model by -0.05m/s per decade) for the last 50 years. But the model ensembles simulate the pattern of the decreasing linear trends over China reasonably.

(2)The surface (land-use) changes such as urbanization and environmental changes of stations are the factors that are mildly responsible for the decreasing trend of both mean and strong wind speeds, except for the changes of anemometers and relocation of stations.

(3)The main direct reason for the decreasing trend of wind speeds is that the wind speed over the troposphere and lower stratosphere is decreased by -0.05 ~ -0.20 m/s per decade in China based on the radio sounding observation and reanalysis data. Most climate models also simulated the reduced wind under 300 hPa by about -0.02 ~ -0.15 m/s per decade in the winter half years.

(4)At the same period, as shown by the observation data, both East Asian winter and summer monsoons are weakened for the last several decades. Most models simulated the winter monsoon over East Asia weakened for the last several decades. But the summer monsoon over East Asia as simulated by the various models is very different.

(5)The global warming might be considered also. Based on the observations, the zonal circulation is strengthening and the meridional circulation is reduced over the middle latitudes of Eurasia. Both cold waves and dust storms in China for the winter half years are decreasing. The warming in China for the last 50 years are significant, especially for the winter half years and Northern and western China where the strong wind are located. It means that the warmer regions are corresponded to the more reduced wind. Most climate models with the human emissions also indicated those results.

The attributions pointed out the impacts of both natural and anthropogenic changes (land-use change and human emissions) on the mean and strong wind weakened.