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Research on the Change of Wind Speeds and Wind Energy in China

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Abstract
The characteristics of changes of both near-surface wind speed and wind direction have been systematic analysis firstly. Further more, the reasons of wind speed change and the impacts of the urbanization, the change of anemometers, relocation of stations, and atmospheric circulation on the wind speed changes have been investigated. And then the simulating capability of 20 global climate models and three regional climate models for wind speed during the past 50 years has been tested. Finally, using the global and regional climate models with the human emissions, both wind and wind power density in the 21st century are projected. The major conclusions are as follows:
The annual mean wind speed (MWS), days of strong wind (SWDs) and maximum wind (MW) all show the declining trends over the broad areas of China. Only in the southeastern Tibetan Plateau and the regions from the Great Bend of the Yellow River southward to Yunnan and Guangxi Provinces wind speeds are not significantly reduced, but rather in partial these regions winds speeds are slightly increased. The frequencies of the annual prevailing wind directions and its wind speed have the decreasing trends, respectively. Both northerly wind (winter) and southerly (summer) prevailing winds in China decreased significantly. Urbanization, the change of anemometers, and relocation of stations, as well as environmental changes of stations are the factors that are mildly responsible for the decreasing trend of MWS. The main reason for the decreasing trend is that under the background of global warming, both East Asian winter and summer monsoons are decreasing, and all of these impacts have resulted in declines of MWS in China.
An evaluation on the wind speeds change over China as simulated by twenty global climate models (during 1956-1999) and three regional climate models (during 1971-1990 and 1990-1999) have been calculated. The studies found that both global climate models and regional climate models have the certain capabilities to simulate the patterns of the annual or seasonal mean wind speeds in China, to compare with the observation. But both global and regional climate models are difficult to simulate the obviously decreased trend of wind speeds. Only a few of them simulate the slightly decreasing trends of annual (or seasonal) wind speed changes in China for the last 50 years. In contrast, the ensemble climate model simulations for the annual and seasonal wind speeds are better than a single model. The simulations of the distributions of surface layer wind speed for the regional climate models are better than that of global climate models.
Both the global climate models and regional climate models are projected that the annual mean wind speeds in China for the 21st century decrease slightly. Among four seasons, the wind speeds in winter (summer) likely decrease (increase) in the entire China, which simulated by global climate models and PRECIS (a regional model). But it is inconsistent with the conclusions of RegCM3, which is better than other regional climate models in simulations of wind speed characters during 1970-1999. Global climate models are more sensitive about human emission scenarios than regional climate models.
Both global climate models and regional climate models are projected that both annual (and the winter half years) averaged wind speed and wind power density during the 21st century are smaller than that during 20th century in China. For summer half years, the projections of the wind changes are inconsistent with each other. In other words, it is more likely that the wind power density for the annual period and the winter half years of the 21st century is smaller than that during the 20th century. For the summer half years, the projections of wind power density for the different models have the relative large uncertainties. The further study will narrow the uncertanties.

Key words: wind speed, wind power density, changes, evaluation, projection