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Surface roughness change significantly affected observed surface wind speed decline in Northern Hemisphere

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The observed surface wind speed at 10 meters above the ground and the geostrophic wind speed calculated from surface pressure collected at 6542 weather stations in the Northern Hemisphere are used to study the reasons for the wind speed decline during 1980-2014. Geostrophic wind reflects the motion of free atmosphere at mid and high latitudes without considering the ground friction, so we can use the difference between the surface wind speed and the geostrophic wind speed to indirectly reflect the effect of surface roughness change on the observed surface wind speed. The results shows that the geostrophic wind speed has a trend of 0.011ms-1 decade-1, 0.010ms-1 decade-1 and 0.168ms-1 decade-1 from 1980 to 2014 in North America, Central Europe, and Eastern Asia, while the SWS trend in these three areas are -0.18ms-1 decade-1, -0.086ms-1 decade-1, -0.156 ms-1 decade-1. By applying the 10th and 90th percentile monthly wind speeds to define weak winds and strong winds, we further found that the decrease of surface wind speed in North Hemisphere was mainly due to the decrease of strong winds, with a declining rate reached 10% decade-1. Weak winds have increased reaching 10% decade-1 in most regions except for the North America. In 1980-2014, geostrophic weak winds are increasing with a trend of 5% decade-1 in Eastern Asia and North America, in most of Europe and Central Asia are mainly decreasing at -8% decade-1. The geostrophic strong winds have an increasing rate ranging from 2% decade-1 to 10% decade-1 in most parts of the Northern Hemisphere except the western part of the Americas.