

EGU2020-13005

<https://doi.org/10.5194/egusphere-egu2020-13005>

EGU General Assembly 2020

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Impact of rapid urbanization on the observed daily maximum wind speed variability: a case study in Yangtze River Delta (China)

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Typhoon and windstorm induced extreme winds (e.g., daily maximum wind speed, DMWS) cause enormous economic losses and deaths in China every year, and rapid urbanization increased surface roughness might play a key role in extreme wind speed variability. Here, observed near-surface (at 10 m height) DMWS from 115 meteorological stations and combined DMSP/OLS (Defense Meteorological Satellite Program/Operational Linescan System) and NPP/VIIRS (Suomi National Polar-orbiting Partnership/Visible Infrared Imaging Radiometer Suite) nighttime light data from 1992-2016 in Yangtze River Delta, a rapidly urbanized area of China, were used to analyze the impact of urbanization on DMWS variability. Raw wind speed observations were subject to a robust quality control and homogenization protocol using the Climatol package. The stations were firstly classified into six urbanized groups by the difference of nighttime light indices of each station between 1992 and 2016. The results show that DMWS in Yangtze River Delta has significantly ($p < 0.05$) declined by $-0.209 \text{ m s}^{-1} \text{ decade}^{-1}$ annually, with negative trends in most seasons, particularly in winter ($-0.470 \text{ m s}^{-1} \text{ decade}^{-1}$, $p < 0.05$) and autumn ($-0.300 \text{ m s}^{-1} \text{ decade}^{-1}$, $p < 0.05$), followed by spring ($-0.178 \text{ m s}^{-1} \text{ decade}^{-1}$, $p > 0.10$), while a weak increase in summer DMWS was found ($+0.002 \text{ m s}^{-1} \text{ decade}^{-1}$, $p > 0.10$). The stations in the highly urbanized group show a higher magnitude in the decline of annual DMWS, indicating the key role of urbanization in weakening DMWS. Further, this is confirmed by the regional climate model (RegCM4) sensitive experiments conducted with different land use and cover data, that is, DMWS in 1992 was higher in the experiment using the real land use and cover data than in the experiment using the land use and cover data in 2016.

