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Variability and trends of near-surface wind speed over the Tibetan Plateau: the role played by the westerly and Asian monsoon

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Near-surface wind speed over the Tibetan Plateau exerts profound impacts on many environmental issues, while long-term (> 50 years) trend and multidecadal variability in the wind speed and its underlying causes in the Tibetan Plateau remain largely unknown. Here, by examining homogenized wind speed data from 104 meteorological stations over the Tibetan Plateau for 1961-2020 and reanalysis datasets, we investigate the variability and long-term trend in the near-surface wind speed and reveal the role played by the westerly and Asian monsoon interaction. The results show that the homogenized wind speed declined (-0.091 m s^{-1} $decade^{-1}$, $p < 0.05$) annually, with the strongest trend in spring (-0.131 m s^{-1} dec^{-1}, $p < 0.05$), and the weakest trend in autumn (-0.071 m s^{-1} dec^{-1}, $p < 0.05$). However, there is a distinct multidecadal variability of wind speed, which manifested in an abrupt increase in wind speed in 1961-1970, a sustained decrease in 1970-2002, and a consistent increase since 2002. The observed variations in NSWS over different studied periods are likely linked to interdecadal variations in atmospheric-ocean interactions, and the correlation analysis unveiled a more important role of background westerly and East Asian winter monsoon in modulating near-surface wind changes over the Tibetan Plateau when compared to East Asian summer monsoon and Indian summer monsoon. The potential physical processes associated with westerly and Asian monsoon changes are further examined, in terms of: (i) regional pressure gradient force (i.e., geostrophic wind speed); (ii) vertical thermal momentum transfer (i.e., atmospheric stratification thermal instability); (iii) vertical dynamic momentum transfer (i.e., vertical wind shear); and (iv) Tibet Plateau Vortices (TPVs). They all partly concord with wind change, which demonstrates, that to varying degrees, these processes are possible causes of near-surface wind speed changes over the Tibetan Plateau.