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Causes for decadal changes in wind speed on the North Hemispheric land surfaces

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Observations indicate a decline of land surface wind speed in the northern Hemisphere of about 0.3 m/s (roughly 10%) in the past 30 years. Such a stilling is sufficient to affect evaporation and climate feedback processes, but may also impact technical applications such as wind power. Here, we carry out extensive sensitivity experiments for the period 1870-2005 with an atmospheric global climate model and assess the role of changes in roughness length as well as the effects of climate forcings. Consistent with previous studies, results show that, depending on the region, an increase of the roughness length by a factor of 1.35 to 2.9 over the past 30 years would be required to reproduce the observed wind stilling. However, such an increase may not necessarily be realistic everywhere.

Additional sensitivity experiments suggest that independently from roughness length changes, past changes in sea-surface temperature and aerosol emissions (atmosphere-only response) also decrease the land surface wind speed after about 1950, explaining up to 20% of the observed stilling. In particular, we find increasing aerosol emissions to generally reduce the surface wind speed after about 1950 in most of the northern hemisphere, by a maximum of 0.3 m/s in India. Results also show that the short-term effects of increased greenhouse gas concentrations is small in comparison to the role of aerosols.