In this work we relate uncertainty in background roughness length \(z_0\) to uncertainty in wind speeds, where the latter are predicted at a wind farm location based on wind statistics observed at a different site. Sensitivity of predicted winds to roughness is derived analytically for the industry-standard European Wind Atlas method, which is based on the geostrophic drag law. We statistically consider roughness and its corresponding uncertainty, in terms of both \(z_0\) derived from measured wind speeds as well as that chosen in practice by wind engineers. We show the combined effect of roughness uncertainty arising from differing wind-observation and turbine-prediction sites; this is done for the case of roughness bias as well as for the general case. For estimation of uncertainty in annual energy production (AEP), we also develop a generalized analytical turbine power curve, from which we derive a relation between mean wind speed and AEP. Following our developments, we provide guidance on approximate roughness uncertainty magnitudes to be expected in industry practice, and we also find that sites with larger background roughness incur relatively larger uncertainties.

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