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A simple and complete model for wind turbine wakes over complex terrain NICK ROMMELFANGER, MAI RAJBORIRUG, PAOLO LUZZATTO-FEGIZ, UC Santa Barbara — Simple models for turbine wakes have been used extensively in the wind energy community, both as independent tools, as well as to complement more refined and computationally-intensive techniques. These models typically prescribe empirical relations for how the wake radius grows with downstream distance x and obtain the wake velocity at each x through the application of either mass conservation, or of both mass and momentum conservation (e.g. Katić et al. 1986; Frandsen et al. 2006; Bastankhah & Porté-Agel 2014). Since these models assume a global behavior of the wake (for example, linear spreading with x) they cannot respond to local changes in background flow, as may occur over complex terrain. Instead of assuming a global wake shape, we develop a model by relying on a local assumption for the growth of the turbulent interface. To this end, we introduce to wind turbine wakes the use of the entrainment hypothesis, which has been used extensively in other areas of geophysical fluid dynamics. We obtain two coupled ordinary differential equations for mass and momentum conservation, which can be readily solved with a prescribed background pressure gradient. Our model is in good agreement with published data for the development of wakes over complex terrain.

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