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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characterization of wind power resource in the United States" *by* U. B. Gunturu and C. A. Schlosser

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The importance to distinguish between kinetic energy flux and wind power potential

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A central assumption in this manuscript is that "wind power density" ($1/2\rho v^3$) and the "wind power resource" are equivalent. This assumption can only be made by considering that the energy extracted by a single turbine has a negligible effect on the atmospheric flow. In general, this assumption cannot be made and results in misleading interpretations of the wind power potential.

'Wind power' is an ambiguous term within the overlapping field of renewable energy and atmospheric science. What is typically referred to as wind power density is actually the atmospheric flux of kinetic energy through a cross-section. This quantity does not, however, specify the rate at which the atmosphere generates kinetic energy, which would be of interest when quantifying the available "resource" of wind power, while additionally recognizing that not all of this kinetic energy can be extracted by turbines. This has long been known in atmospheric science (e.g. Gustavson, 1979), but despite its importance, these considerations are unfortunately absent in much of the literature that attempts to quantify "wind power potentials" from wind fields derived from observational or reanalysis data.

The discrepancy between the term "wind power density" and the actual ability to extract wind power sustainably becomes very clear in the extreme case of nearly-geostrophic flow, such as jet streams, which require almost no power to sustain the flow. When

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additional drag in the form of turbines is introduced to the flow, the stock of kinetic energy is very quickly reduced, and little power can be sustainably extracted from the flow despite initially high wind velocities (see Miller et al. 2011a). Even though the effect is not as clear near the surface, the assumption that all of the kinetic energy flux can be converted into wind power also does not hold (see Miller et al. 2011b).

Hence, we strongly recommend that the authors use the correct meteorological term of "kinetic energy flux", use the term "wind power resource" with caution, and discuss the limitations of this concept.

References

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