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Interactive comment on "The problem of the second wind turbine – a note on a common but flawed wind power estimation method" *by* F. Gans et al.

H. Held (Editor)

held@pik-potsdam.de

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Gans, F., L.M. Miller and A. Kleidon, "The problem of the second wind turbine- a note on a common but flawed wind power estimation method."

The authors of this note demonstrate in a heuristic model that wind power draws energy from the motions of the atmosphere near the earth's surface, which derive their kinetic energy from the down-gradient flux of momentum from the atmosphere above. That momentum, in turn is restored by the forces arising due to the differential heating of the atmosphere by the sun. For net wind farm generation to exceed the present day production of kinetic energy in the atmosphere, the large scale circulation of the

atmosphere would have to change rather dramatically in response to the increased roughness of the surface, something that is intuitively unlikely and has never arisen in any simulation of the impact of surface roughness on the atmospheric flow. In fact, all simulations of total wind power generated by a practically maximal distribution of wind turbines that have included the additional roughness due to wind turbines themselves have demonstrated reduced wind power in regions where roughness is increased, relative to a control (e.g. Kirk-Davidoff and Keith, 2008; Barrie and Kirk-Davidoff, 2010; Wang and Prinn , 2010).

However, the conclusion of the note, that estimates of wind power that are based on the simple approach of applying prevailing winds to typical turbine power curves, may result in "worthless âĂŤ and possibly dangerous âĂŤpolicy advice" is not remotely justified by the work presented. The essential message of the papers that have actually simulated maximal wind power exploitation is that total dissipation of kinetic energy at the earth's surface in any given region is mostly determined by the large scale circulation. Thus, one can shift the locus of this dissipation from grass blades to wind turbine hubs, but one can't expect to add much extra dissipation.

Policy makers are a long way from bumping up against these limits. For example, the state of South Dakota has an area of 200,000 km^2. Assuming an average dissipation of 1.5 W m^{-2}, this would indicate an upper limit of about 150 GW of wind power (dividing by two to account for the Betz limit) that could be generated over South Dakota. The current installed wind power capacity over the whole United States is about 30 GW. The world is thus in no danger of bumping up against the fundamental limits of wind power production any time soon. Since state-of-the-art estimates of the ultimate wind resource (e.g. Wang and Prinn, 2010) already address the concerns that Miller et al. raise, it seems unlikely that any terrible policy mistakes will be made by over-reliance on the first order estimates of the total wind resource made without regard to the synoptic scale reduction of winds due to the turbines themselves.

References:

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(Reported by Kirk-Davidoff, D.B., dankd@atmos.umd.edu)

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