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Weather response to a large wind turbine array

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Abstract. Electrical generation by wind turbines is increasing rapidly, and has been projected to satisfy 15% of world electric demand by 2030. The extensive installation of wind farms would alter surface roughness and significantly impact the atmospheric circulation due to the additional surface roughness forcing. This forcing could be changed deliberately by adjusting the attitude of the turbine blades with respect to the wind, which would enable the "management" of a large array of wind turbines. Using a General Circulation Model (GCM), we represent a continent-scale wind farm as a distributed array of surface roughness elements. Here we show that initial disturbances caused by a step change in roughness grow within four and a half days such that the flow is altered at synoptic scales. The growth rate of the induced perturbations is largest in regions of high atmospheric instability. For a roughness change imposed over North America, the induced perturbations involve substantial changes in the track and development of cyclones over the North Atlantic, and the magnitude of the perturbations rises above the level of forecast uncertainty.

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