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Stochastic Modeling of Turbulence-Driven Systems: Application to Wind Energy P. MILAN, M. WAECHTER, J. PEINKE, ForWind - Center for Wind Energy Research, FORWIND - CENTER FOR WIND ENERGY RESEARCH OF THE UNIVERSITIES OF OLDENBURG, HANNOVER AND BREMEN TEAM — The recent increase in the exploitation of the wind energy resource stresses the need for fundamental research in fluid dynamics. The complex wind inflows that drive wind turbines affect their availability in terms of electric power production, as well as in operation lifetime. Short-scale turbulent effects in the wind such as intermittency, as well as large-scale atmospheric non-stationarity lead to ever-changing power signals fed into the electric grid. This calls for a theoretical classification of wind energy phenomena into complex, turbulence-driven systems. Our raising dependence on wind energy requires a better understanding of these phenomena, as well as reliable models. A stochastic model is proposed as an alternative to standard wind energy models that often neglect turbulent effects or CFD models that cannot decribe large wind turbines yet. This model is based on the stochastic equation of Langevin that can simulate these complex systems after their proper characterization. This stochastic model can be applied separately on both atmospheric wind speed signals as well as wind turbine power production signals, after the wind turbine was characterized properly. The signals generated display the proper statistics and represent fast and flexible models for wind energy applications such as monitoring, availability prediction or grid integration. A future analysis of fatigue loads is also under development.

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