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Analytical modeling of turbine wakes in yawed conditions

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Increasing wind energy production has become a unanimous plan for virtually all the developed countries. In addition to constructing new wind farms, this goal can be achieved by making wind farms more efficient. Control strategies in wind farms, such as manipulating the yaw angle of the turbines, have the potential to make wind farms more efficient. Costly numerical simulations or measurements cannot be, however, employed to assess the viability of this strategy in the numerous different scenarios happening in real wind farms. In this study, we aim to develop an inexpensive and simple analytical model that is able for the first time to predict the whole wake of a yawed turbine with an acceptable accuracy. The proposed analytical model is built upon the simplified version of the Reynolds-averaged Navier-Stokes equations. Apart from the ability of the model to predict wake flows in yawed conditions, it can provide a better understanding of turbine wakes in this complex situation. For example, it can give valuable insights on how the wake deflection varies by changing turbine and incoming flow characteristics, such as the thrust coefficient of the turbine or the ambient turbulence.