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Analytical model for yawed turbine asymmetric wakes. MICHELE GUALA, St. Anthony Falls Laboratory, CEGE, University of Minnesota, BINGZHENG DOU, LIPING LEI, PAN ZENG, Department of Mechanical Engineering, Tsinghua University — Due to large scale atmospheric variability and slow nacelle adjustments, wind turbines are predominantly operating in yawed conditions. In addition, to minimize turbine-turbine interactions and maximize spatially averaged energy production in wind power plant arrays, the yaw angle becomes a control variable for operators to steer the wake of front row units away from downwind rotors. Both mechanisms are expected to be relevant also for Marine Hydrokinetic (MHK) Turbines, experiencing large scale variability due to migrating bedforms in fluvial or tidal flows. We present a new wake model able to predict the location of the maximum velocity deficit, and the asymmetric distribution of the mean velocity about the wake center, for different downwind distances (Dou et al., 2019). The model has been calibrated using wind tunnel and open channel flow experiments with yawed miniature turbines of different shape, size and operating conditions. The key advantages of the proposed wake model are: i) the model requires only the thrust coefficient in un-yawed conditions, ii) the required parameter describing the wake expansion has been observed to be weakly depending on specific incoming flow condition, iii) the parameter describing the wake asymmetry can be estimated based on the yaw angle and the thrust coefficient. Thus, input parameters of the proposed model are for the most part limited to the turbine geometry, its operating conditions, and the associated thrust coefficient.

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