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A fast wind-farm boundary-layer model to investigate gravity wave effects and upstream flow deceleration[1] DRIES ALLAERTS, JOHAN MEYERS, KU Leuven — Wind farm design and control often relies on fast analytical wake models to predict turbine wake interactions and associated power losses. Essential input to these models are the inflow velocity and turbulent intensity at hub height, which come from prior measurement campaigns or wind-atlas data. Recent LES studies [1,2] showed that in some situations large wind farms excite atmospheric gravity waves, which in turn affect the upstream wind conditions. In the current study, we develop a fast boundary-layer model that computes the excitation of gravity waves and the perturbation of the boundary-layer flow in response to an applied force. The core of the model is constituted by height-averaged, linearised Navier–Stokes equations for the inner and outer layer, and the effect of atmospheric gravity waves (excited by the boundary-layer displacement) is included via the pressure gradient. Coupling with analytical wake models allows us to study wind-farm wakes and upstream flow deceleration in various atmospheric conditions. Comparison with wind-farm LES results shows excellent agreement in terms of pressure and boundary-layer displacement levels. [1] Allaerts D. and Meyers J., J. Fluid Mech. 814, 95-130 (2017) [2] Allaerts D. and Meyers J., Boundary-Layer Meteorol. (Revision submitted)

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