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Wind veer and wind speed in turbulent Ekman flow

Cedrick Ansorge[1] and Hauke Wurps[2]
[1]Universität zu Köln, Institut für Geophysik und Meteorologie, Geowissenschaften, Köln, Germany (cedrick@posteo.de)
[2]Carl von Ossietzky Universität Oldenburg, Institut für Physik, Oldenburg, Germany

The profiles of wind speed and direction in turbulent Ekman flow are formulated based on asymptotic theory and data from direct numerical simulation. The profile of the streamwise component follows the classical viscous, logarithmic and wake scaling. In the outer layer, the velocity component profiles can be described by an Ekman-spiral with adapted boundary conditions that result in a reduction of the spiral-like rotation. The span-wise component poses a conceptual challenge to the channel-flow analogy in the context of asymptotic matching; it exhibits a mixed scaling in the surface layer, but follows outer scaling for most of the outer layer. Viscous stress scales universally across the boundary layer in inner units while the total stress becomes universal as a function of outer height. This implies a mixed scaling for the turbulent stress and eddy viscosity across the inner layer and convergence to a universal scaling as function of the outer height across the outer layer for increasing scale separation vide Reynolds numbers.