What happens with the Ekman current under constant wind?

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The work examines the Ekman current response to a steady wind within the Stokes-Ekman paradigm. Under constant wind in the classical Ekman model there is a single attractor corresponding to the Ekman (1905) steady solution. It is known that the account of wind waves strongly affects the Ekman current dynamics via the Stokes drift, which is described by the Stokes-Ekman model. Waves continue to evolve even under constant wind, which makes steady solutions of the Stokes-Ekman equation impossible. Since the dynamics of the Ekman response in the presence of evolving wave field have not been considered, the basic questions on how the Ekman current evolves and, especially, whether it grows or decays at large times, remain open.

Here by employing the known self-similar laws of wave field evolution and solving analytically the Stokes-Ekman equation we find and analyse evolution of the Ekman current. We show that the system has a single time dependent attractor which can be described asymptotically. The large time asymptotics of the Ekman current is found to be determined by the regime of wave field evolution: for the regimes typical of young waves the Ekman current grows with time to infinity, in contrast, for ‘old waves’ the Ekman current asymptotically decays.