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Wave - current interactions through stochastic physics

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Swells from strong storms can spread over very long distances. Ocean currents alter this propagation, with the possible formation of constructive or destructive interference. This effect, still neglected in current models of atmospheric, oceanic, and even wave prediction, is often traced in current measurements, altimetry or even scatterometry / radiometry at medium and high resolution.
Large-scale currents are indirectly measured by satellite. Since the small-scale currents are generally unknown, we propose to consider them as random in wave dynamics simulations. Specifically, the statistical spatial structure of these currents is inferred from large-scale currents through self-similar assumptions. The temporal correlations of the small-scale currents is neglected due to the short-time wave-current interaction. The dispersion ratio is modified and becomes stochastic. From there, we can derive and simulate the random dynamics of wave group the rays. Analytic and semi-analytic solutions have also been derived for simple – though realistic – cases.
Our results not only improve wave simulation capabilities, but also bring new insights about the large wave's developments at small scales and the wave-current effects on satellite measurements. At longer term, those type of random dynamics will bring new data assimilation procedures for joint wave-current estimations from space.