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Reduced-order prediction of rogue waves in two-dimensional deep-water waves[1] THEMISTOKLIS SAPSIS, MOHAMMAD FARAZMAND, MIT — We consider the problem of large wave prediction in two-dimensional water waves. Such waves form due to the synergistic effect of dispersive mixing of smaller wave groups and the action of localized nonlinear wave interactions that leads to focusing. Instead of a direct simulation approach, we rely on the decomposition of the wave field into a discrete set of localized wave groups with optimal length scales and amplitudes. Due to the short-term character of the prediction, these wave groups do not interact and therefore their dynamics can be characterized individually. Using direct numerical simulations of the governing envelope equations we precompute the expected maximum elevation for each of those wave groups. The combination of the wave field decomposition algorithm, which provides information about the statistics of the system, and the precomputed map for the expected wave group elevation, which encodes dynamical information, allows (i) for understanding of how the probability of occurrence of rogue waves changes as the spectrum parameters vary, (ii) the computation of a critical length scale characterizing wave groups with high probability of evolving to rogue waves, and (iii) the formulation of a robust and parsimonious reduced-order prediction scheme for large waves.

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