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Uncertainty propagation using spectral methods and flow map composition DIRK M. LUCHTENBURG, STEVEN L. BRUNTON, CLARENCE W. ROWLEY, Princeton University — Uncertainty quantification is becoming more widely used in a variety of applications: for instance, when analyzing oil spills, one wants to predict the extent of the contaminated region, but the velocity field is not known precisely. We propose an efficient method for computing the propagation of a probability density function (PDF) through the long-time, nonlinear flow map associated with an uncertain fluid velocity field. Uncertain initial conditions and parameters are both addressed. The method approximates the short-time flow map by a spectral basis and uses flow map composition to construct the long-time flow map. The short-time flow map is characterized by small stretching and folding of the associated trajectories and hence can be represented by a relatively low-order basis. The composition of these low-dimensional bases then accurately describe the uncertainty behavior for long times. We use sampling of the spectral representations to compute stochastic quanti- ties, such as the mean and variance. The method is applied to several numerical examples including the long-time advection of a distribution of particles through an uncertain velocity field.

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