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Bayesian Identification of Oil Spill Source Parameters from Image Contours

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Oil spills at sea pose a serious threat to the coastal environment. Identifying oil pollution sources could help to investigate unreported spills, and satellite imagery can be an effective tool for this purpose. We present in this work a Bayesian approach to estimate the source parameters of a spill from contours of oil slicks detected by remotely sensed images, i.e., from satellites and/ or drones. The approach adopts an observation error model based on a non-local measure of the dissimilarity between the predicted and observed contours. A Markov chain Monte Carlo technique is then employed to sample the posterior distribution of five parameters of interest: the 2D coordinates of the source of release, the time and duration of the spill, and the quantity of oil released. To make the estimation of the posterior distribution computationally feasible, an iterative algorithm is adopted to construct polynomial chaos-based surrogates that fit the oil model locally (around the true value of the source parameters), guided by surrogate-based posterior distributions that would eventually converge to the true posterior distribution. Two synthetic experiments of a spill released from a fixed point source are investigated, where a contour is completely observed in the first case, while two contours are partially observed at different times in the second case. In both experiments, the proposed framework is able to provide good estimates of the source parameters along with a level of confidence reflected by the uncertainties within. In the case of partial observations, the estimated parameters can be used to reconstruct the missing parts of an observed slick from which an oil spill model can be initiated to better forecast the oil spread.