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Kriged Kalman filtering for predicting the spatio-temporal wildfire temperature process evolution (Conference Paper)

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Abstract

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Existing wildfire evolution models have been mostly developed in a deterministic modelling framework. As a complementary alternative, in this paper, we study the problem of predicting the spatio-temporal wildfire temperature process evolution using the Kriged Kalman filtering framework. In particular, the spatio-temporal temperature process is decomposed into a mean process and a residual process. The mean temperature process is further decomposed into a linear combination of fixed spatial basis functions with stochastic temporal coefficients that evolve in time, whereas the residual temperature process is modelled as a zero-mean spatio-temporal Gaussian process. In the Kriged Kalman filtering framework, one challenge is to specify a suitable set of spatial basis functions that gives a good representation of the process. By solving the partial differential equation that governs the principal heat transfer mechanisms driving the wildfire evolution, we show that the spatio-temporal mean temperature process associated with a wildfire evolving in a finite spatial domain under certain prescribed conditions can be approximated by a Fourier series. One key novelty in our work is that we explicitly incorporate the physics of the wildfire evolution process in deriving a suitable choice of spatial basis functions that approximate the mean temperature process. We also derive an evolution model for the temporal coefficients of the mean temperature process based on the proposed heat transfer partial differential equation. Finally, we demonstrate the potential of the proposed Kriged Kalman filtering framework in simulations on temperature data generated by a simplified physical wildfire evolution model.

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