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Estimation of Spatial-temporal Source Term of Chernobyl Wildfires using Deep Neural Network Prior

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The source term of Chernobyl 2020 wildfires is a tensor consisting of five dimensions: spatial location described by longitude and latitude in a given area with potentially many sources, time profiles, height above ground level, and the size of particles carrying the material. Since the number of concentration measurements is limited, the estimation of this source term is an ill-posed problem. Prior information is thus essential to obtain a reproducible estimate. We show that deep image prior that utilizes the structure of a deep neural network to regularize the inversion is suitable for this problem. The deep network is initialized randomly without the need to train it on any dataset first. The networks is used to represent both the mean and variance of the posterior estimate. The resulting variational Bayes procedure thus introduces smoothness in the spatial estimate of the emissions and reduces the number of unknowns by enforcing a prior covariance structure in the source term. The estimate of the 137Cs emissions during the Chernobyl wildfires in 2020 is compared to the Tikhonov method. The spatial distribution of the proposed method is close to the distribution obtained from satellite observations.

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