Simulation of Random 3-D Trajectories of the Toxic Plume Spreading over the Terrain

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An efficient software tool for purposes of simulation of random evolution of the concentration distribution of toxic admixtures originally discharged into the atmosphere is presented. The main goal of the development is its application as a pivot algorithm of the multiple recalled root of the Sampling-Importance-Resampling procedure for online Bayesian tracking of the plume trajectory progress. A certain variant (e.g. variance reduction by marginalisation) of Particle Filter originating from common sequential Monte Carlo method with adaptive resampling is applied consequently in joint analysis for simulation of the posterior distribution of the system state (e.g. time and spatial distribution of the pollution concentration). The 3-D trajectories represent the “particles”, and during the resampling, those particles having small weights with regard to the measurements are eliminated.

The ensemble of 3-D trajectory realisations offers good basis for uncertainty analysis and studies of sensitivity. These analyses should involve uncertainties due to stochastic character of input data, insufficient description of real physical processes by parametrisation, incomplete knowledge of submodel parameters, uncertain release scenario, simplifications in computational procedure etc. It facilitates to follow the recent trends in risk assessment methodology insisting in transition from deterministic procedures to probabilistic approach which enables to generate more informative probabilistic answers on assessment questions. Limited number of the most important random model parameters is selected for parametrisation of the 3-D trajectories.

The environmental model of pollution transport itself is based on segmented plume-puff modification of the classical Gaussian approach. Our poster illustrates the results related both to the probability approach of consequence assessment and generation of inputs inevitable for assimilation (prior physical knowledge included in the background fields and model error covariance structure). Real scenario of radioactivity dissemination analysed here demonstrates the complexity of the problem requiring a good degree of understanding and ad hoc developments.