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Evaluations of a data assimilation methodology in a nuclear emergency response system

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Since the Chernobyl accident nuclear emergency preparedness has been in a continuing process of testing and upgrading the decision support systems with the best available techniques. In recent years data assimilation is introduced within atmospheric dispersion modelling to improve the prognoses of the radiological situation using measured results. The data assimilation methodology introduced here is based on varying the input space to optimise the calculated results.

In the first step, the monitored radiation levels are related to the calculated radiation levels from source-term estimates based on the plant status using RIVM's validation tool [1]. In the second step a robust minimisation algorithm adjusts various input parameters of the model while monitoring the "Figure of Merit". When a convergence criterion is satisfied the minimisation algorithm stops and reveals the optimal input space.

The Kincaid data set is used to demonstrate the validity of the data assimilation technique revealing the most favourable input parameters for the air dispersion model. In a previous paper [2], we showed that the data assimilation technique is capable to automatically adjust two input parameters resulting in an optimised dispersion calculation. For this paper we have extended the method to nine parameters to optimise the input space. It is shown that the dispersion modelling could be improved considerably, while the number of required iterations remained limited, thus assuring timely results. Within the Kincaid experiment one day (25 July 1980) was chosen to illustrate the strength of the data assimilation. For this day the meteorological information and the observed concentrations are inconsistent leading to total disagreement between measured and modelled results (giving a value for the "Figure of Merit" of 100). Including the data assimilation methodology the "Figure of Merit" dropped to 39.5 (a "Figure of Merit" of 0 indicates a perfect agreement, and 30 to 40 indicate a reasonable good agreement). The minimisation algorithm was satisfied after 122 iteration steps.

[1] Eleveld H, H Slaper, "Development and application of an extended methodology to validate short-range atmospheric dispersion models", Quantitative Methods for Current Environmental Issues edited by Anderson et al., Springer-Verlag London. ISBN 1852332948. January 2002. 147-165.

[2] Eleveld H, YS Kok , CJW Twenhöfel, "Data assimilation, sensitivity and uncertainty analyses in the Dutch nuclear emergency management system; a pilot study", accepted for publication in International Journal of Risk Assessment and Management.