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Revisiting the radionuclide atmospheric dispersion event of the Chernobyl disaster - modelling sensitivity and data assimilation

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A sensitivity study of the numerical model, as well as, an inverse modelling approach applied to the atmospheric dispersion issues after the Chernobyl disaster are both presented in this paper. On the one hand, the robustness of the source term reconstruction through advanced data assimilation techniques was tested. On the other hand, the classical approaches for sensitivity analysis were enhanced by the use of an optimised forcing field which otherwise is known to be strongly uncertain.

The POLYPHEMUS air quality system was used to perform the simulations of radionuclide dispersion. Activity concentrations in air and deposited to the ground of iodine-131, caesium-137 and caesium-134 were considered. The impact of the implemented parameterizations of the physical processes (dry and wet depositions, vertical turbulent diffusion), of the forcing fields (meteorology and source terms) and of the numerical configuration (horizontal resolution) were investigated for the sensitivity study of the model.

A four dimensional variational scheme (4D-Var) based on the approximate adjoint of the chemistry transport model was used to invert the source term. The data assimilation is performed with measurements of activity concentrations in air extracted from the Radioactivity Environmental Monitoring (REM) database.

For most of the investigated configurations (sensitivity study), the statistics to compare the model results to the field measurements as regards the concentrations in air are clearly improved while using a reconstructed source term. As regards the ground deposited concentrations, an improvement can only be seen in case of satisfactorily modelled episode.

Through these studies, the source term and the meteorological fields are proved to have a major impact on the activity concentrations in air. These studies also reinforce the use of reconstructed source term instead of the usual estimated one. A more detailed parameterization of the deposition process seems also to be able to improve the simulation results. For deposited activities the results are more complex probably due to a strong sensitivity to some of the meteorological fields which remain quite uncertain.