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A comparative sensitivity analysis focused on wet deposition models for the Fukushima and Chernobyl atmospheric dispersion events

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In order to model the transport of radionuclides bound to atmospheric particles and the ground contamination at the synoptic scale, the wet deposition is a crucial point. Usually, the wet deposition is divided in two different mechanisms, the below-cloud scavenging (washout) and the in-cloud scavenging (rainout). Since the micro-physics of both deposition processes is not well known yet, the modeling of the wet deposition of particles at the synoptic scale is uncertain and difficult to validate. This leads to an abundance of wet deposition models, none of them being fully adequate.
The existing models of particle scavenging can be distinguished by the nature and the number of physical parameters they rely on. For instance the scavenging coefficient variability can be determined only by the rainfall intensity or take into account the rainfall intensity and the particle size distribution. Beyond their intrinsic formulations, the deposition models are sensitive to the input data necessary to use them, cloud height for instance. Finally, the simulated ground deposition is more or less sensitive to the choices of the overall-models involved in the atmospheric transport of particles and the meteorology in general. For accidental atmospheric releases, the uncertainties linked to the source-term are for instance crucial, what justifies the use of different ones in the study. The Polyphemus air quality system is used to perform the simulations of the radioactive dispersion, considering Caesium-137 as particulate matter for the accidental releases from the Fukushima and Chernobyl nuclear power plants. In this study, two different approaches are used. In the first one, the influence of the different components taking part in the scavenging modeling are confronted separately (whether the scavenging models or the overall models). The second approach is a global sensitivity analysis computed both on the Chernobyl and Fukushima cases. It relies on simulations performed with several combinations of possible models that influence the wet deposition. These results are then compared to ground deposition observations, in order to determine the best model configurations, or at least to identify the worst ones, for each case. This study also enables the emphasis on sets of “good” or “bad” combinations common to both cases. The large number of models combinations implemented is also useful to investigate the robustness of reconstructed source terms, which are here determined on the basis of only one model configuration. Finally, the aim is to provide a better view of the limits of the currently available models.