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The new conversion model MODERN to derive erosion rates from inventories of fallout radionuclides

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The measurement of fallout radionuclides (FRNs) has become one of the most commonly used methods to quantify soil erosion and depositional processes. FRNs include anthropogenic radionuclides (e.g. 137Cs, 239+240Pu) released into the atmosphere during nuclear bomb tests and power plant accidents (e.g Chernobyl, Fukushima-Daiichi), as well as natural radiotracers such as 210Pbex and 7Be. FRNs reach the land surface by dry and wet fallouts from the atmosphere. Once deposited, FRNs are tightly adsorbed by fine soil particles and their subsequent redistribution is mostly associated with soil erosion processes. FRNs methods are based on a qualitative comparison: the inventory (total radionuclide activity per unit area) at a given sampling site is compared to that of a so called reference site. The conversion of FRN inventories into soil erosion and deposition rates is done with a variety of models, which suitability is dependent on the selected FRN, soil cultivation (ploughed or unploughed) and movement (erosion or deposition).
The authors propose a new conversion model, which can be easily and comprehensively used for different FRNs, land uses and soil redistribution processes. This new model i.e. MODERN (MOdelling Deposition and Erosion rates with RadioNuclides) considers the precise depth distribution of a given FRN at a reference site, and allows adapting it for any specific site conditions.
MODERN adaptability and performance has been tested on two published case studies: (i) a 137Cs study in an alpine and unploughed area in the Aosta valley (Italy) and (ii) a 210Pbex study on a ploughed area located in Romania. The results show a good agreement and a significant correlation ($r = 0.91$, $p < 0.0001$) between the results of MODERN and the published models currently used by the FRN scientific community (i.e. the Profile Distribution Model and the Mass Balance Model). The open access code and the cost free accessibility of MODERN will ensure the promotion of a wider application of FRNs for investigating soil erosion and sedimentation processes.