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A NEW LOOK AT OLD DATA – A SIMPLE MODEL FOR ESTIMATING DEPOSITION BASED ON A STATISTICAL REASSESSMENT OF GLOBAL FALLOUT DATA

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Atmospheric testing of nuclear weapons began in 1945 and came largely to an end in 1963. Extensive monitoring was done on the global fallout from these tests. The Environmental Measurements Laboratory (EML) in the US had a global network as well as the UK Atomic Energy Research Establishment (AERE / Harwell). There were also comprehensive national networks such as operated by the Risø National Laboratory in Denmark. Early analysis of the data showed correlation of deposition with precipitation. Global compilations of deposition data, such as by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), showed clearly an uneven distribution with latitude. Subsequently this has in some cases been used as a deposition model, even though the original papers warn against this and recommend that precipitation should rather be used to model the deposition variability in a region.

In our study we reanalysed the EML, AERE and Risø data from 1945 – 1976 for Sr-90 and Cs-137 using analysis of covariance (ANCOVA) and logarithmically transformed values of the monthly deposition density as the response variable. Generalized additive models (GAM) were used to explore the relationship of any given explanatory variables to the response variable and quantify the explanatory power that could be achieved. The aim was to identify which explanatory variables would explain most of the variability and then to create a simple linear model that would produce similar explanatory power as the GAM. The effects of latitude were clear when using global data, but of minor importance when narrowing the latitude range to a belt (30 - 70°N) north of the Hadley cell circulation close to the equator. Longitude had also limited explanatory power. Much of the variability of the data could be explained by precipitation at each site and generic change with time (same for all sites). Radionuclide deposition (Cs-137 and Sr-90) can thus be estimated at a site if the precipitation history is known. Our paper shows how the estimates improve as the temporal resolution of the precipitation data increases. The UNSCEAR reports point out that other radionuclides in global fallout were deposited in proportional amounts to Sr-90, e.g. Pu. This was confirmed by our analysis of the data sets. It also showed that the EML data were slightly but significantly lower than the others.

The deposition rate could be explained as a simple non-linear power function of the precipitation rate ($p^{0.6}$). If the monthly precipitation was excessive, further increases had no explanatory power. It should be noted that a similar non-linear power function relationship has been the outcome of some studies linking washout and rainout coefficients with rain intensity. In our paper we demonstrate how this could be linked to our results. The results show that the precipitation rate is an important parameter, not only the total amount. Our simple model allows the recreation of the deposition history at a site. This is useful for comparison with time series of activity concentration, e.g. in food products, which is important for model validation.