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Size distributions of airborne radionuclides derived from the Fukushima nuclear accident at several places in Europe

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Segregation and radioactive level analysis of aerosols according to their aerodynamic size were performed in France, Austria, Czech Republic, and Poland after the arrival of contaminated air masses following the nuclear accident at the Fukushima Daiichi nuclear power plant (FDNPP). Sampling was performed from 23rd of March to 23th of April 2011. Whatever the location, the higher activity levels correspond to the finest particle fraction available through Andersen impactors or high volume impactors. As a general pattern, the highest contributions to the 137Cs and 134Cs ambient activity level were supported by the finest size range investigated (aerodynamic diameter $<$ 0.49 micrometre). The Activity Median Aerodynamic Diameter (AMAD) ranged from 0.27 to 0.71 micrometre and an average of 0.45 micrometre for cesium isotopes whereas lower values were obtained for 131I (0.4 micrometre on average). In addition, geometric standard deviation appears to be larger for iodine than for cesium isotopes; probably as a result of gaseous transfer onto ambient particles of all sizes during transport. Contribution from resuspension of formerly deposited 137Cs was assessed for the coarse particle fractions. AMAD values obtained for natural occurring radionuclides such as 7Be and 210Pb ranged from 0.4 to 0.5 micrometre; and 0.3 to 0.4 micrometre, respectively. Larger AMAD values were obtained for 234Th (3.3 micrometre) and 228Ac (3.6 micrometre), both radionuclides coming from the resuspension of coarse particles induced by wind erosion of soil surfaces. For the Fukushima-derived fission products, highest weighted activity levels were not found onto the finest particles ($<$ 0.49 micrometre) but in the upper size fraction [0.49 ? 0.95 micrometre] with specific activity levels of about 22 Bq/g for 131I and around 5 Bq/g for both cesium isotopes. This study also provides a spatial and temporal analysis at the European scale of AMAD values of anthropogenic radionuclides found at significant levels (134Cs, 137Cs, 131I) as well as for radionuclides of natural origin (7Be). 137Cs and 134Cs AMAD values at the European scale show spatial homogeneity whereas they gradually decrease from the arrival date to the end of the studied period. This pattern is also observed for 7Be but with a less pronounced decrease. A specific time trend can be noticed for particulate 131I (see fig.). Increasing 131I AMAD values can support the idea of a progressive transfer of gaseous iodine onto ambient aerosols as proposed by Uematsu et al (1988) after the Chernobyl accident or also recently suggested by Mala & Rulik (2013) or Dlugosz-Lisiecka & Bem (2012) after the FDNPP accident.

Figure: Time variation of the AMAD value of Fukushima-labelled aerosols (134Cs, 137Cs, 131I and 7Be) in Europe after the arrival of the contaminated air masses (mean values from several sampling sites in Europe).

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