

Key issues in radionuclide labeled aerosol monitoring for resuspension studies and short to long-term post-accident characterizations

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The French radioactive aerosol monitoring network (OPERA) celebrates its fiftieth anniversary this year. This monitoring was gradually updated both in terms of aerosol sampling (up to 700 m³/h) and radioactivity measurement in order to determine current airborne levels as low as 0,2 µBq/m³ for ¹³⁷Cs. One of the key issues in monitoring is linked to understanding the environmental transfer processes. These processes affect radioactive aerosols inside the atmospheric compartment (rainout, washout, dry deposition and impaction). Radioactive aerosol are also emitted from others compartments of the biosphere that received radionuclide fallout (via resuspension or biomass burnings). The least soil particle resuspension that has ¹³⁷Cs concentration of some hundreds to tens thousands Bq/m² (like in France) is enough to increase airborne levels temporarily. This is especially true during Saharan dust events because of high dust flux, even if the Saharan soil particle activity is lower. About a dozen Saharan events are count every year especially in the southern half of France. During Saharan dust outbreaks the daily airborne activity levels is correlated with PM10 evolution (fig. 1). Moreover the activity levels in deposited dust collected in France are quite concentrated when compared to the Saharan soils. This enrichment is due to the coarse particule segregation loss that have less affinity with ¹³⁷Cs than fine particles. Our findings show that yearly averaged activity levels are twice to ten times higher for altitude locations (mountainous). The cruising altitude of Saharan plumes is responsible of this.

Fires also lead to redistribution of formerly deposited radionuclides, mainly due to the burning of radionuclide-enriched forest litter even over long distances. During winter, temperature inversion in the lower atmospheric layers coupled with wood burning for domestic purposes may also lead to temporary increases in airborne artificial radionuclide levels. Except for these extreme events, routine and local resuspension, regular in time and mainly dependant on season also contributes to the background level. Local resuspension effect can also be found in the better relationship with ¹³⁷Cs airborne activity when considering coarse particles (PM₁₀) that don't travel far from their emission area, instead of fine particles (PM_{2.5}). In France a six year long study shows that oceanic air flux is correlated to a light positive longitudinal airborne activity gradient from west to east whereas there is no background PM₁₀ gradient (15 µg.m⁻³). Thus, the activity gradient can be explained by the soil activity related to the longitudinal Chernobyl fallout distribution. During eastern winds a remote contribution is added from areas more impacted by Chernobyl fallout. This added contribution results in quite the same averaged gradient but with 3 times more pronounced values at both France boundaries and a 4 times enhanced variability. At the scale of France and for the last 8 years, local and remote resuspension can explain about 1/3 of ¹³⁷Cs rising levels; biomass burnings 1/3 too. The last third corresponds to winter temperature inversion coupled with domestic wood burning emissions. Enhancing knowledge about these mechanisms is useful to mapping territorial radioecological sensitivity and to explain long term post-accident persistence of airborne radionuclides at trace levels. Current needs are concerning the radionuclide aerosol size segregation.

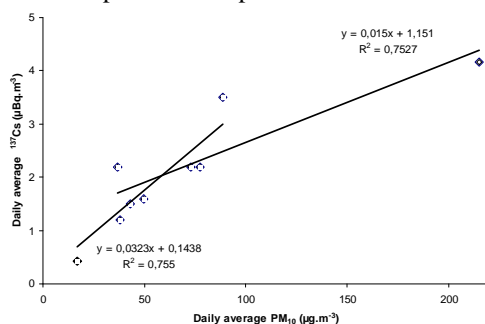


Fig.1: Relationship between ¹³⁷Cs activity level and PM₁₀ of mineral origin from Sahara