Wet deposition of radionuclides in France following the Fukushima accident

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1 INTRODUCTION

After the Fukushima accident, the IRSN introduced quickly an extended monitoring plan to estimate potential radiological consequences due to the passage of contaminated air masses over the French territory. Part of this plan consisted in sampling rainwaters and aerosols at three sites (Figure 1) to measure their activity levels.

2 OBJECTIVES

Wet depositions of ^{131}I (half-life of 8 days), ^{134}Cs (half-life of 2,1 years) and ^{137}Cs (half-life of 30,1 years) were quantified, and a particular interest focused on scavenging coefficients reflecting combined effects of in-cloud scavenging (rainout) and below-cloud scavenging (washout) of radionuclides.

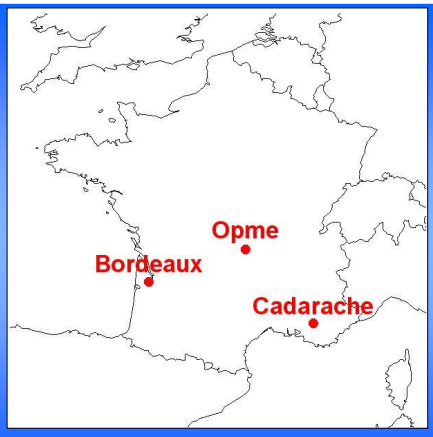

Figure 1 : Location of the sampling sites

3 METHODS

Rainwater was sampled with bulk collectors of 1m² and aerosols with high-flow samplers. Activity levels in air and water were determined using low-background HPGe detectors after two different treatment protocols. Crude rainwaters were first measured in a Marinelli beaker of 3L of capacity prior to their concentration by complete evaporation at 70°C, assuming the removal of the volatile fraction of ^{131}I by this way.

4 RESULTS

Calculation methods for results shown below are detailled in Depuydt et *al.* (2012). Dry deposition for each sampling period was estimated and it was considered as a first approximation that it could be neglected compared to wet deposition. Scavenging coefficients Λ (s^{-1}) for particulate radionuclides were determined and a parametrization of the form $\Lambda = a*Rb$, with R the rainfall intensity, a and b specifics coefficients depending on the radionuclide studied, was deduced. Results are summarized in Table 1.

Table 1 : Wet deposition values in France and scavenging coefficients

Radionuclide	Range of wet deposition values ($mBq.m^{-2}$)	Average wet coefficient (s^{-1})	Parametrization
Total ^{131}I	432 - 31280		
Particulate ^{131}I	197 - 28300	$[5,1 \pm 2,1] .10^{-4}$	$\Lambda = 5.10^{-5} * R^{1,43}$
^{134}Cs	8 - 367	$[0,9 \pm 0,5].10^{-4}$	$\Lambda = 2.10^{-6} * R^{2,30}$
^{137}Cs	10 - 500	$[1,1 \pm 0,5] .10^{-4}$	$\Lambda = 3.10^{-6} * R^{2,16}$

In comparison, after the Chernobyl accident, the highest value of wet deposition of ^{137}Cs was of the order of 107 $mBq.m^{-2}$ in lowland.

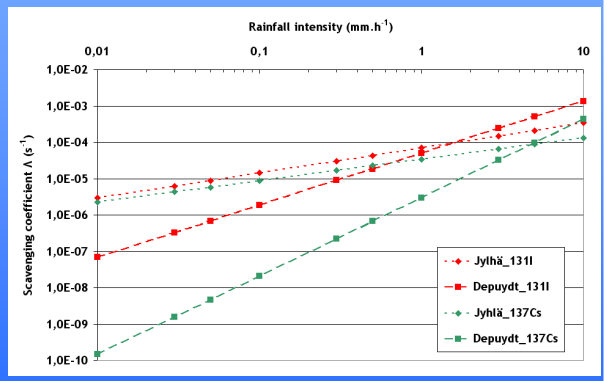

Figure 2 : Comparison of our parametrization with that of Jylhä

This parametrization was compared with a similar study performed by Jylhä (1991) in Finland after the Chernobyl accident (Figure 2). Our parametrization is in quite good agreement for rainfall intensities higher than 0.1 $mm.h^{-1}$ (for ^{131}I) or few $mm.h^{-1}$ (for ^{137}Cs).

5 CONCLUSION

After the Fukushima accident, the highest deposit of ^{137}Cs in France is negligible (~ 1%) compared to that observed following the Chernobyl accident. Scavenging coefficients estimated from *in situ* measurements represent the overall effect of wet deposition processes, in-cloud and below-cloud scavenging, with average values of about 5.10^{-4} s^{-1} for particulate iodine-131 and about 1.10^{-4} s^{-1} for cesium-137 and cesium-134.

References

Jylhä, K., 1991. Empirical scavenging coefficients from radioactive substances released from Chernobyl. Atmospheric Environment - Part A General Topics, 25 A(2), p.263-270.

Depuydt G., Masson O., De Vismes A., Orjollet D., Renaud P., Paulat P., 2012. Wet deposition of radionuclides in France following the Fukushima accident. Under submission.