Geophysical Research Abstracts
Vol. 15, EGU2013-10479, 2013
EGU General Assembly 2013

Impact of vegetation and ecosystems on chlorine(-36) cycling and its modeling: from simplified approaches towards more complex biogeochemical tools

Yves Thiry (1), Paul-Olivier Redon (1), Malin Gustafsson (2), Laura Marang (3), and David Bastviken (2)

(1) Andra, Research &Development Division, Châtenay-Malabry, France (yves.thiry@andra.fr, +33 1 46 11 82 08), (2) Department of Thematic Studies - Water and Environmental Studies - Linköping University, Linköping, Sweden, (3) EDF-R&D - Laboratoire National d'Hydraulique et Environnement, Chatou, France

Chlorine is very soluble at a global scale with chloride (Cl^-), the dominating form. Because of its high mobility, chlorine is usually perceived as a good conservative tracer in hydrological studies and by analogy as little reactive in biosphere. Since ^{36}Cl can be considered to have the same behaviour than stable Cl, a good knowledge of chlorine distribution between compartments of terrestrial ecosystems is sufficient to calibrate a specific activity model which supposes rapid dilution of ^{36}Cl within the large pool of stable Cl and isotopic equilibrium between compartments. By assuming ^{36}Cl redistribution similar to that of stable Cl at steady-state, specific activity models are simplified interesting tools for regulatory purposes in environmental safety assessment, especially in case of potential long term chronic contamination of agricultural food chain (IAEA, 2010). In many other more complex scenarios (accidental acute release, intermediate time frame, and contrasted natural ecosystems), new information and tools are necessary for improving (radio-)ecological realism, which entails a non-conservative behavior of chlorine.

Indeed observed dynamics of chlorine in terrestrial ecosystems is far from a simple equilibrium notably because of natural processes of organic matter (SOM) chlorination mainly occurring in surface soils (Öberg, 1998) and mediated by microbial activities on a large extent (Bastviken et al. 2007). Our recent studies have strengthened the view that an organic cycle for chlorine should now be recognized, in addition to its inorganic cycle. Major results showed that:

1. organochlorine (Cl_{org}) formation occurs in all type of soils and ecosystems (culture, pasture, forest), leading to an average fraction of the total Cl pool in soil of about 80 % (Redon et al., 2012),
2. chlorination in more organic soils over time leads to a larger Cl_{org} pool and in turn to a possible high internal supply of inorganic chlorine (Cl_{in}) upon dechlorination. (Gustafsson et al., 2012),
3. average Cl residence time in forest soils calculated for Cl_{in} and Cl_{org} together was 5-fold higher that the residence time estimated for Cl_{in} alone (Redon et al., 2011),
4. locally, Cl amount taken up by certain vegetation types can be larger than annual atmospheric deposits, the Cl in excess being recycled mainly by throughfall (Thiry, 2010),
5. root uptake and chlorine transformation rates in soils are essential to calibrate dynamic compartment models since those processes control the persistence of chlorine in the whole system but data are still deficient for different land uses (Van den Hoof & Thiry, 2012).

References:

Bastviken, D., Thomsen, F., Svensson, T., Karlsson, S., Sandén, P., Shaw, G., Matucha, M., and Öberg, G. (2007). Chloride retention in forest soil by microbial uptake and by natural chlorination of organic matter. *Geochim. Cosmochim. Acta*, 71: 3182-3192.

Gustavsson, M., Karlsson, S.,Öberg, G.,Sandén, P.,Svensson, T.,Valinia, S.,Thiry, Y. and Bastviken, D. (2012). Organic matter chlorination rates in different boreal soils: the role of soil organic matter content. *Environmental Science & Technology,* 46 (3): 1504-1510

Thiry, Y., 2010. Contribution à l'étude du cycle biogéochimique du chlore en écosystème forestier: cas d'un peuplement de pin sylvestre. Rapport Andra n°ENV.NT.ASTR.10.0068.

IAEA (2010). Handbook of parameter values for the prediction of radionuclide transfer to humans in terrestrial and freshwater environments. Technical Report Series n˚472, Vienna, Austria.

Öberg, G. (1998). Chloride and organic chlorine in soil. *Acta hydrochimica et hydrobiologica,* 26 (3): 137-144.

Redon, P-O., Abdelouas, A., Bastviken, D., Cecchini, S. Nicolas, M. and Thiry, Y. (2011). Chloride and organic chlorine in forest soils: storage, residence times, and influence of ecological conditions. *Environmental Science & Technology,* 45: 7202-7208.

Redon, P-O., Jolivet, C., Saby, N., Abdelouas, A.and Thiry, Y. (2012). Occurrence of natural organic chlorine in soils for different land uses. *Biogeochemistry (In press),* doi: 10.1007/s10533-012-9771-7.

Van den Hoof, C. and Thiry, Y. (2012). Modelling of the natural chlorine cycling in a coniferous stand: implications for chlorine-36 behaviour in a contaminated forest environment. *Journal of Environmental Radioactivity*., 107: 56-67.