Variability of ^{13}C-^{14}C in soil CO_2: Impact on ^{14}C groundwater ages

MARINA GILLON[1,2*], FLORENT BARBECOT[2], ELISABETH GIBERT[2], CAROLINE PLAIN[3], JOSÉ ANTONIO CORCHO ALVARADO[4], AND MARC MASSAULT[2]

[1]UMR UAPV-INRA 1114 EMMAH, Avignon, France, marina.gillon@univ-avignon.fr (*presenting author)
[2]UMR CNRS-UPS 8148 IDES, Orsay, France, florent.barbecot@u-psud.fr, elisabeth.gibert@u-psud.fr, marc.massault@u-psud.fr
[3]UMR UL-INRA 1137 EEF, Nancy, France, plain@nancy.inra.fr
[4]Institute of Radiation Physics, University Hospital and University of Lausanne, Lausanne, Switzerland, Jose.Corcho@chuv.ch

The ^{14}C age correction models for groundwater use generally an input function that depends on the carbon isotopic composition (^{13}C and ^{14}C) of the soil CO_2. However, in most cases the activity ($A^{14}C$) of atmospheric CO_2 is directly used as input function without considering processes occurring in soil and leading to significant isotopic changes between the composition of atmospheric CO_2 and of soil CO_2 [1][2]. We present here the role of these processes as well as the associated isotopic changes and their impact on the calculation of the age of groundwater. Our approach is based on the use of experimental data from two sites (Fontainebleau sands and Astian sands, France) and its interpretation by a distributed model [3].

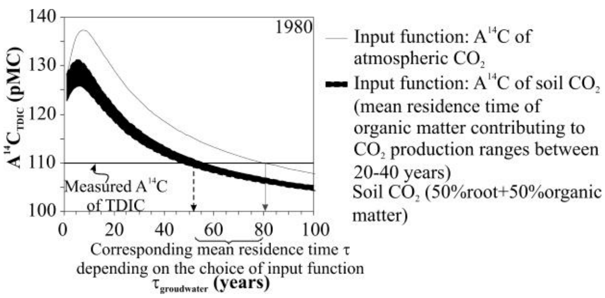

Figure 1: Calculated mean ages of groundwater with respect to different input function; case of a theoretical sampling in 1980.

Since 1950, the evolution of the $A^{14}C$ in soil CO_2 reflects the competition between the fluxes of root derived-CO_2 and organic matter derived-CO_2 due to the residence times of organic matter in the soil. We demonstrate that a mean ^{14}C groundwater age based purely on the ^{14}C atmospheric data may lead to significant biases [2]. For example, a measured $A^{14}C$ of 110 pMC in 1980 corresponds to a mean age of 50±5 or 80±2 y depending on the choice of the input function (Fig. 1). Moreover, the analytical $\delta^{13}C$ of soil CO_2 showed large seasonal variations. Therefore, for dating modern groundwater, a systematic sampling of soil CO_2 has to be integrated into numerical simulations to define ^{13}C-^{14}C content at the water table [4].

[1] Fontes (1992) *Radiocarbon After Four Decades*, 242-261; [2] Gillon et al. (2009), *Geochim. Cosmochim. Acta* **73**, 6488-6501; [3] Gillon et al., *geoderma*, in revision; [4] Gillon (2008), Ph. D. Thesis, Paris Sud XI Univ., France.