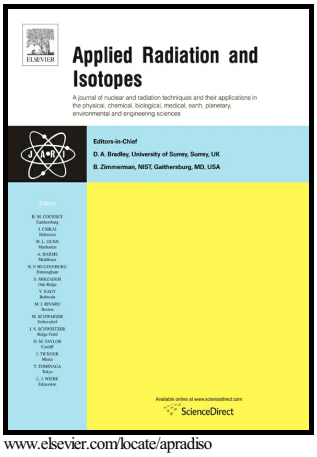

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Radiocarbon concentration in tree-ring samples collected in the south-west Slovakia (1974-2013)

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Abstract:

Radiocarbon measurements of tree-ring samples collected in Vysoká pri Morave were compared with tree-ring data of the Žlkovce monitoring station situated 5 km south-east from the Jaslovské Bohunice Nuclear Power Plant (NPP). Radiocarbon concentrations in Vysoká pri Morave and in Žlkovce tree rings were decreasing exponentially with decay constants of 14.48±1.23 y and 17.96±1.97 y, respectively, in agreement with similar results obtained at other radiocarbon stations. The Suess effect, represented by a dilution in ^{14}C levels by fossil fuel CO_2 emissions, was observed in both tree-ring data sets. The Vysoká pri Morave ^{14}C data were during 1974-1995 systematically lower by about 50‰ than the Schauinsland (Germany) clean air reference values due to a regional fossil-fuel impact. However, after 1996 the Vysoká pri Morave ^{14}C data were closer to the Schauinsland data due to lower CO_2 emissions as a result of closing some of the heavy industry technologies in the region.

Keywords: radiocarbon; atmospheric CO_2; tree rings; nuclear power plant

1. Introduction

Radiocarbon produced in the atmosphere by cosmic rays, or released from nuclear installations, forms $^{14}CO_2$ molecules which are then absorbed along with $^{13}CO_2$ and $^{12}CO_2$ by autotrophic organisms (predominantly plants) during photosynthesis. The absorbed carbon is used by trees to form cellulose molecules during their growth, which means that the atmospheric carbon (and radiocarbon) is incorporated into the wood's structure. The annual growth rings therefore contain carbon from a well-defined time period and are an excellent tool for environmental studies of the past ^{14}C levels in the atmosphere and biosphere. In addition to natural radiocarbon concentration changes due to solar modulation of cosmic rays and geomagnetic shifts (Stuiver and Quay, 1980), anthropogenic influences can be observed in these records as well. Nuclear weapon tests in the 1950s and 1960s caused a *bomb peak* – about 100% increase of radiocarbon levels in the atmosphere (Levin and Hesshaimer, 2000). Nuclear power plants and reprocessing facilities also release additional ^{14}C into the atmosphere (Uchrin et al., 1998; Povinec et al., 2008).

Anthropogenic fossil CO_2 emissions (eg. from combustion of coal and oil), which are ^{14}C-free, dilute the radiocarbon concentration in the atmosphere. This phenomenon is called Suess effect and due to atmospheric mixing it has both regional and global character (Levin and Hesshaimer, 2000).

The aim of this work has been to present and discuss three radiocarbon data sets: the tree-ring data from Vysoká pri Morave, and the tree-ring and atmospheric data from Žlkovce. The Žlkovce monitoring station is located 5 km south-east from the Jaslovské Bohunice Nuclear Power Plant (NPP), and an increase of anthropogenic ^{14}C has been observed at this site (Povinec et al., 2008). Vysoká pri Morave is a small village only 30 km north-west from the capital city Bratislava, and the effect of fossil CO_2 emissions on radiocarbon concentration has been expected. The location of the sampling sites on a map of Slovakia can be seen in Fig. 1.

2. Materials and methods

2.1 Vysoká pri Morave and Žlkovce tree-ring samples