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Variations of anthropogenic carbon dioxide in urban area deduced by radiocarbon concentration in modern tree rings

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The aim of this work was to investigate local Suess effect, caused by CO_2 emission from fossil fuel use, by using annual tree ring samples. By comparison of radiocarbon concentration in investigated area with that in clean air is possible to calculate the radiocarbon decrease caused by this effect. In this work three location were investigated; Nagoya (centarl Japan), Kraków (southern Poland), Arequipa (southern Peru) and Valladolid (central Spain). Those places are located in both southern and northern hemispheres in three different zones. Experimental results show a gradual decrease in radiocarbon activity over time caused by local Suess effect. A decrease of 15.2‰ per year (Nagoya A) and 8.2‰ per year (Nagoya B) of $\delta^{14}C$ for tree rings were obtained for the periods between 1968 and 2002 and between 1985 and 2003, respectively. In Krakow decreases of 7.1‰ per year for tree rings and 9.15 ‰ per year for atmospheric radiocarbon concentrations were noted for the period between 1983 and 2002. In Arequipa during the period between 1986 and 2001 a decrease has reached value of 6.9‰ per year, and in Valladolid 6.36.9‰ per year between year 1986 and 2007. The results achieved for Nagoya, Arequipa and Valladolid represent yearly average value, while for Kraków only average value during the growing season between April and September. The yearly average value of fossil fuel component (C_{foss}) in Nagoya for the period 1967-2002 was 12.6 ppmV (Nagoya A). Because of different location, the average value of fossil fuel component in Nagoya B is lower (3.6 ppmV). The big differences can be occurred due to different condition in which the two trees were growing. The values of 5.9 ppmV and 6.5 ppmV were obtained by tree rings and atmospheric CO_2 data from Kraków, respectively and represent the April-September average for the period 1983-2003. In Valladolid for a period between years 1986 and 2007, value of 5.1 ppmV has been observed. The lowest yearly average value of fossil fuel component of 2.7 ppmV was obtained for Arequipa for the period 1986-2001, while the value 4.56 ppmV calculated for the period 1986-1992 is more similar to the values obtained for Kraków and Valladolid in this work.

All samples were collected by hollow drill giving amount of samples enough to measure by AMS system. The biggest advantage of this method is possibilities of using small samples easy to collect in any interesting place for investigation, which was mostly impossible with conventional radiocarbon methods.

Using this method was possible to compare radiocarbon concentration in atmospheric CO_2 with that in tree rings growing nearby, to determinate the growing season. All those results show that, with isotopic information recorded in tree rings, it is possible to reconstruct radiocarbon concentration in the past, and data like this can also be used for analytical calculation. It is also possible to calculate fossil fuel component c_{foss}using data of radiocarbon concentration measured in tree rings. For this calculation can be used data of radiocarbon concentration and concentration of CO_2 in “clean air” reported in literature.