Geophysical Research Abstracts
Vol. 14, EGU2012-117, 2012
EGU General Assembly 2012

Cosmogenic 14C in situ formation by cosmic ray nucleons in polar ice

A. Nesterenok (1,2)

(1) Ioffe Physical-Technical Institute, Saint Petersburg, Russia (alex-n10@yandex.ru), (2) St. Petersburg State Polytechnic University, Saint Petersburg, Russia

The radiocarbon deposition in polar ice is a complex process depending on many factors. Radiocarbon is incorporated in ice by trapping atmospheric gases during transformation of firn into glacier ice. In addition, nuclear interactions of energetic neutrons and muons of cosmic rays create ^{14}C in firn and ice, as these are accumulated and in ablating ice as it outcrops. In situ ^{14}C has been used to determine the ablation rate of outcropping ice in Antarctica, and the presence of an in situ signal in an accumulating ice has been confirmed in experiments.

There is no consensus in the literature about radiocarbon production rates in ice and published values differ in two times. In the present work, we study interactions of cosmic rays with the Earth's atmosphere and ice exposed at the Earth's surface. The emphasis of this work is on radiocarbon in situ formation by cosmic ray nucleons in polar ice. We calculate the production rate of the nuclide for sea level high geomagnetic latitudes using various sets of cross section data. The comparison is made between our results and experimental data. The recalculation of the radiocarbon production rates for different glacier elevations is discussed.

The effective attenuation length of high energy spallation reactions in ice is found to be Λ_{ice} = 130 g/cm^2 for high geomagnetic latitudes, which is lower than the values accepted in previous studies of in situ ^{14}C in polar ice, 150-160 g/cm^2. Accurate determination of this parameter is important for radiocarbon concentration calculations for ice samples from ablating areas of ice sheet. The 15% error in parameter Λ_{ice} leads to 50% error in calculated concentrations of ^{14}C at depth of $3\Lambda_{ice}$ in ice.

The energy distribution of product nuclei ^{14}C formed in neutron-induced spallation of oxygen has been simulated. Calculated energy distribution of daughter nuclei ^{14}C can be used as an input parameter for simulations of chemistry of hot atoms. Accurate determination of radiochemical yields of ^{14}C hot reaction products is necessary for radiocarbon dating of polar ice samples and for studies of $^{14}CH_4$ trapped in polar ice.

The results of this work are published in Nuclear Instruments and Methods in Physics Research B 270 (2012) 12-18.