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Testing the potential of ^{10}Be in varved sediments from two lakes for solar activity reconstruction

Markus Czymzik (1), Raimund Muscheler (1), Achim Brauer (2), Florian Adolphi (1), Florian Ott (2), Ulrike Kienel (2), Nadine Dräger (2), Michal Slowinski (3), Ala Aldahan (4,5), and Göran Possnert (6)

(1) Lund University, Department of Geology, Lund, Sweden , (2) German Research Centre for Geosciences, Section 5.2, Potsdam, Germany, (3) Polish Academy of Sciences, Institute of Geography and Spatial Organization, Torun, Poland, (4) Uppsala University, Department of Earth Sciences, Uppsala, Sweden, (5) UAE University, Department of Geology, Al Ain, United Arab Emirates, (6) Uppsala University, Tandem Laboratory, Uppsala, Sweden

The potential of ^{10}Be in annually laminated (varved) lake sediments for solar activity reconstruction is, to date, largely unexplored. It is hypothesized that ^{10}Be contents in sediments from well-chosen lakes reflect the solar induced atmospheric production signal. The varved nature of these archives provides the chance to establish solar activity time-series with very high temporal precision. However, so far solar activity reconstruction from ^{10}Be in varved lake sediments is hampered due to a lack of detailed knowledge of the process chain from production in the atmosphere to deposition on the lake floor. Calibrating ^{10}Be time-series from varved lake sediments against complementary proxy records from the same sediment archive as well as instrumental meteorological and solar activity data will allow a process-based understanding of ^{10}Be deposition in these lakes and a quantitative evaluation of their potential for solar activity reconstruction.

^{10}Be concentration and flux time-series at annual resolution were constructed for the period 1983 to 2007 (approx. solar cycles 22 and 23) conducting accelerator mass spectrometry and varve chronology on varved sediments of Lakes Tiefer See and Czechowski, located on an east-west transect at a distance of about 450 km in the lowlands of northern-central Europe. ^{10}Be concentrations vary between 0.9 and 1.8*10^{8}atoms/g, with a mean of 1.3*10^{8}atoms/g in Lake Tiefer See and between 0.6 and 1.6*10^{8}atoms/g, with a mean of 1*10^{8}atoms/g in Lake Czechowski. Calculated mean ^{10}Be flux is 2.3*10^{8}atoms/cm^{2}/year for Lake Tiefer See and 0.7*10^{8}atoms/cm^{2}/year for Lake Czechowski. Calibrating the ^{10}Be time-series against corresponding geochemical μ-XRF profiles, varve thickness and total organic carbon records as well as precipitation data from the nearby stations Schwerin for Lake Tiefer See and Koscierzyna for Lake Czechowski and a neutron monitor record of solar activity suggests (1) a complex interaction of varying processes influencing ^{10}Be deposition in both lakes and (2) that neither ^{10}Be concentrations nor fluxes are the most suitable indicator of solar variability alone. Multiple regression analyses indicate that the combined ^{10}Be concentration and flux time-series account for about 80% (Tiefer See) and 40% (Lake Czechowski) of the variability in the neutron monitor record, sufficient to reconstruct variability related to the 11-year solar cycle.