Geophysical Research Abstracts
Vol. 17, EGU2015-6943-1, 2015
EGU General Assembly 2015

Northeast Siberian ice wedges reveal Arctic long-term winter warming over the past two millennia

Thomas Opel (1), Hanno Meyer (1), Thomas Laepple (1), Sebastian Wetterich (1), Martin Werner (2), Alexander Dereviagin (3), and Lutz Schirrmeister (1)

(1) Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Periglacial Research Section, Potsdam, Germany (thomas.opel@awi.de), (2) Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Paleoclimate Dynamics Section, Bremerhaven, Germany, (3) Moscow State University, Department of Geocryology, Faculty of Geology, Moscow, Russia

The Arctic currently experiences a pronounced and unprecedented warming. This highly dynamic response on changes in climate forcing and the global impact of the Arctic water, carbon and energy balance make the Arctic a key region to study past and future climate changes on different spatial, temporal and seasonal scales.

Recent proxy-based Arctic and Northern Hemisphere temperature reconstructions show a long-term cooling trend over the past millennia that has been reversed by the ongoing Arctic warming. This cooling is mainly related to the decrease in summer insolation. Climate models on the other hand show no significant change or even a slight warming. This model-proxy mismatch might be caused by a summer bias of most records. Hence, there is strong need for past winter climate information. Moreover, the Russian Arctic is largely underrepresented in recent Arctic-wide proxy compilations. Ice wedges may help to fill these seasonal and spatial gaps.

Polygonal ice wedges are a widespread permafrost feature in the Arctic coastal lowlands. They are formed by the periodic repetition of wintertime frost cracking and subsequent crack filling in spring mostly by melt water of winter snow. Hence, the isotopic composition of wedge ice is indicative of past climate conditions during this extended winter season. δ18O of ice is interpreted as proxy for local air temperatures. Radiocarbon dating of organic remains in ice-wedge samples enables one to generate chronologies for single ice wedges as well as stacked records with an up to centennial resolution.

Here we present ice-wedge records from the Oyogos Yar coast in the Northeast Siberian Arctic (72.7°N, 143.5°E) that cover the past two millennia. We discuss the chronological approaches as well as the paleoclimatic findings.

The co-isotopic relationship of wedge ice is close to the Global Meteoric Water Line pointing to no significant isotopic changes during ice-wedge formation and, therefore, to a good suitability for paleoclimate studies.

Our ice wedge data show a clear long-term warming trend over the past two millennia detectable in single ice wedge profiles as well as in a stacked record. This trend culminates in an unprecedented rise over the last decades reflecting the ongoing Arctic warming and reaching the absolutely highest δ18O values found in Late Quaternary ice wedges in the study region. These findings are related to the increases in winter insolation as well as in greenhouse gas forcing over the past two millennia. However, this temperature pattern is in contradiction to most other Arctic temperature records that, in turn, are likely summer-biased. This underlines the seasonally different orbital forcing trends.

Our ice-wedge record adds therefore unique and substantial climate information for understanding the seasonal patterns of Late Holocene paleoclimate. It supports recent findings from Holocene ice wedges in the Lena River Delta and might help bridging the gap between proxy records and climate models in the Arctic.