



A varved lake sediment record from Finland: between the North Atlantic Oscillation and Siberian High Pressure Cell

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Varved lake sediments are widely used for paleoclimatological and paleoenvironmental studies. The advantages of such records are precise time control, which enables high resolution studies of even seasonal scale, and the length of the records extending potentially beyond thousands of years.

The clastic organic varved sediments from a small boreal Lake Kalliojärvi (area 0.15 km², maximum depth 12 m) in Central Finland, record environmental change and snow accumulation history for more than two thousand years. The high quality sediments of the Lake Kalliojärvi are laminated until the present day and reflect the annual circulation of boreal zone. A single varve year consists of two laminae that are composed of i) minerogenic clasts and ii) amorphous organic matter and microfossils. Total varve thickness was measured, and the accumulation of minerogenic and organic matter were analyzed using digital image analysis. The major element composition of the lake sediments was also determined using micro X-ray fluorescence (μ -XRF).

The clastic laminae are interpreted as a proxy for catchment erosion, reflecting spring floods triggered by snow melt. Qualitative comparison of minerogenic matter accumulation and reconstructed North Atlantic Oscillation (NAO) phases reveal correspondence between the two records. Positive NAO conditions occur simultaneously with increased minerogenic lamina thicknesses which suggest that the changes in snow accumulation are induced by NAO. However, there are indications that the strong Siberian High Pressure Cell (SHPC) prevailing on eastern Scandinavia may be important for Scandinavian climate via blocking the westerly winds. Strong SHCP potentially leads to colder winter temperatures in Finland and increased ice formation. Stronger and prolonged ice cover in lake environments cause prolonged water column stratification and increased oxygen deficiency which is related to an increased Fe/Mn ratio.

This study discusses the importance of NAO and SHPC for winter climate in Fennoscandia and evaluates the usability of the lake sediment Fe/Mn ratio as a proxy for strengthened Siberian High Pressure Cell.