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# Detail climate reconstructions based on combined geochemistry of lake sediments and tree-ring data by the example of Altai Mountains

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Our knowledge of climate change with associated forcing during the last thousand-years remains limited because that cannot be studied thoroughly by instrumental data. So it is an actual task to find high resolution paleoclimate records and to compare it with recent patterns of short-period oscillations. Combination of lake sediments and tree rings appears to be effective for understanding of regional climate variability.

The Altai mountain range in Central Asia has a climate divide between Siberian forests in the North and arid areas of Central Asia in the South. This region is characterized by the highest degree of continentality. In winter, due to the prevailing stable Siberian High, cold and dry arctic air masses are predominant. In summer, humid air masses from the Atlantic Ocean as well as recycled moisture are the main sources of precipitation.

There are several dendrochronologies (up to 1700 years long) and annual reconstructions by Teletskoye Lake sediments (3000 years) in Altai region. They are calibrated by data from 14 local weather stations (time series up to 80 years) and Barnaul station (170 years) as well. The frequencies analysis of tree-ring width chronologies from Altai using by the spectral analysis shows that high frequencies are dominate. Most of cycles have periodicity up to 40 years. Maximum amplitude were found for 32.3, 142,9 and 200 year. High frequencies (2-40 years) are explain more 60% variability of tree-ring width chronologies. Decadal variabilities are found for 32.3, 40.0 and 43.5 years. Last two cycles are the same as Brikner cycle and could explain decadal moisture variability in Altai and Central Asia.

Typical mountains lakes - Teletskoye and Kucherla - with accumulation rate of the fine-grained sediments 0,5-2 mm/year and free of human impact are selected to take sediment cores.

A new generation of X-Ray Fluorescence instruments – the XRF scanner on Synchrotron Radiation – allows providing extraordinary high-resolution (up to 0.1 mm) records of elemental composition due to low threshold of detectability of many elements from Al to U. XRF scanning realizes rapid and non-destructive determinations, making sedimentary cores comparable with tree-rings. Also thin-sections are studied to examine the nature of laminas in order to better understand signals extracted.

Time series of lithological-geochemical indicators of climate change based on dating by 14C, 137Cs, and 210Pb are calibrated by instrumental hydrometeorological data to obtain the functions as environmental reconstructions.

About 10 elements determined in sediments remain valid as climatic proxies after preliminary testing of analytical accuracy and variability. Set of elements depends on sediment composition, which is differing in sampled lakes. Organophillic elements have larger coefficients in equations for temperature reconstructions, but clastophillic ones are greater in formulas of multiple regression for precipitation. Good correlation between sedimentary-geochemical reconstructions and local dendrochronologies is revealed.

So we used tree-ring series together with element contents as an additional proxy for calculation of transfer function, considering that tree-ring series are responsed to summer temperature in this climatic zone. Such combined version allows taking one more independent

environmental indication for objective reconstructions. Another direction for use is detailed elaboration for sparse pollen or diatoms sequences. Multi-elemental geochemical matrix also allows prolongation of many instrumental time-series such as lake level, runoff, tree rings, atmospheric pressure, wind direction, solar activity etc.