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Holocene Lake Records on Kamchatka

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The availibility of terrestrial records of Holocene palaeoenvironmental changes in eastern Siberia still is quite limited, compared to other regions on the northern hemisphere. In particular, the Kamchatka Peninsula as an important climate-sensitive region is very underrepresented. Situated at the border of northeastern Eurasia, the maritime-influenced terrestrial setting of Kamchatka offers the potential to pinpoint connections of environmental changes between the periglacial and highly continental landmasses of eastern Siberia and the sub-Arctic Pacific Ocean and Sea of Okhotsk. The study region lies at the eastern end-loop of the global thermohaline ocean conveyor belt and is strongly affected by atmospheric teleconnections. Volcanic, tectonic, and glacial processes overprint palaeoenvironmental changes in addition to primary climate forcing.

In order to widen our understanding of plaeoclimate dynamics on Kamchatka, sediment cores from different lake systems and peat sections were recovered and analysed by a multi-proxy approach, using sedimentological and geochemical data as well as fossil bioindicators, such as diatoms, pollen, and chironomids. Chronostratigraphy of the studied records was achieved through radiocarbon dating and tephrostratigraphy. Sediment cores with complete Holocene sedimentary sequences were retrieved from Lake Sokoch, an up to six metre deep lake of proglacial origin, situated at the treeline in the Ganalsky Ridge of southern central Kamchatka (53°15,13'N, 157°45.49' E, 495 m a.s.l.). Lacustrine sediment records of mid- to late Holocene age were also recovered from the up to 30 m deep Two-Yurts Lake, which occupies a former proglacial basin at the eastern flank of the Central Kamchatka Mountain Chain, the Sredinny Ridge (56°49.6'N, 160°06.9'E, 275 m a.s.l.). In addition to sediment coring in the open and deep Two-Yurts Lake, sediment records were also recovered from peat sections and small isolated forest lakes to compare palaeoecologocal responses in different lake systems under same climatic boundary conditions.

Our findings give evidence of longterm climate changes that suggest the existence of a warm and humid early Holocene climate optimum between roughly 9.0 and 4.5 ka BP, followed by climate deterioration of the neoglacial epoch in concert with summer cooling, glacial advances, and enhanced continentality. Two strong cooling episodes punctuated late Holocene climate development between 4.5 and 3.5 ka BP and during the last millennium, marking the prelude of neoglacial cooling and the Little Ice Age. This general development of Holocene climate on Kamchatka is in line with environmental changes in the neighbouring Sea of Okhotsk, where the pattern of sea-ice dynamics is consistent with early Holocene warmth and Neoglacial climate cooling. While the marine records from the Sea of Okhotsk mainly reflect winter conditions, our findings show that summer climate on Kamchatka shows a similar trend of temporal change. Holocene climate variability on Kamchatka was mainly driven by external insolation forcing, changes in solar activity, and internal climate forcing. The latter is dictated by by the relative position of the Aleutan Low in response to the prevailing modes of Pacific Decadal Oscillation and the Arctic Oscillation that both control the influence of maritime or continental air masses and the intensity of rain- or snow-bringing cyclones.