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The Okhotsk Sea - Changes in Intermediate Water ventilation during the last 25,000 years

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The Okhotsk Sea is one of only three regions in the world ocean where large-scale active ventilation of intermediate-depth water masses occurs. This ventilation and subsequent mixing processes result in the formation of Okhotsk Sea Intermediate Water (OSIW), which in turn is largely responsible for ventilating North Pacific Intermediate Water. Few, if any, well-dated proxy-records are available so far that track the evolution of OSIW formation and ventilation from the glacial through the deglaciation into the Holocene with sufficient temporal resolution.

To overcome this lack, we present results from several radiocarbon-dated sediment cores that we recovered from core layer depths (600-1000 m) along the up- and downstream regions of OSIW formation within the Okhotsk Sea basin. We use stable carbon and oxygen isotopes of planktic and benthic foraminifera in connection with diverse bulk sediment nutrient proxies to derive a history of ventilation patterns and hydrographic variability of OSIW for the last 25,000 years with an average sample resolution of 20-200 years. Our findings are constrained by AMS ^{14}C dates of benthic-planktic foraminiferal pairs and calculated ventilation ages for key intervals. We observe short-term variability in δ^{18}O and δ^{13}C signatures both for mixed layer and bottom water masses, in agreement with isotope datasets we derived from modern water-profile samples sets.

Better ventilated OSIW than today during the glacial MIS 2 is contrasted by reduced or lacking ventilation during the deglaciation with minimum δ^{13}C values during the Bølling-Allerød and the earliest part of the Holocene. At the Sakhalin margin, the occurrence of laminated sections in a deeper core attest to the short-term development

of an Oxygen-Minimum Zone at the same time. In contrast, at intervals of nearly ceased North Atlantic Deep Water (NADW) production during Heinrich Event I, we find evidence for maxima of OSIW ventilation in epibenthic δ^{13}C data.

The mid-Holocene time interval is generally less ventilated than today and we suppose that formation of OSIW was diminished and sometimes ceased during this interval. From ca. 4 to 5 kyr BP onwards, increased OSIW ventilation coincides with changes to more unstable and colder climatic situations in adjacent Siberia and SE Asia, expressed in a weakening of the SE Asian summer and a strengthening of the winter monsoon, factors that today precondition the near-shore shelf regions for OSIW formation by brine rejection and enhanced winter mixing.

On a hemispheric scale, throughout the Holocene, principal centennial to millennial-scale variability of temperature and OSIW ventilation coincide with major changes in NADW production. However, no exact one-to-one correlation is evident, pointing to distinctly different forcing mechanism and feedbacks for the two basins and implying no simple link by oceanic circulation changes alone.