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Holocene Intermediate Water Ventilation in the Okhotsk Sea and North Pacific

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The Okhotsk sea is one of only a three main regions in the world ocean where 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. Theses formation rates and ventilation patterns of OSIW may be also crucial factors for the oxygenation history and the intermittent development of Oxygen Minimum Zones at large parts of the NE Pacific continental margin.

However, few if any well-dated records are available so far that track the evolution of OSIW formation and ventilation through the deglacial and 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) within the up- and downstream region of the OSIW formation regions 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 transient history of ventilation patterns and hydrographic variability of OSIW for the last 15,000 years with an average sample resolution of 20-100 years. Our findings are constrained by AMS 14C dates of benthic-planktic foraminiferal pairs and calculated ventilation ages for key intervals. We observe short-term variability in oxygen and carbon isotope 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 late glacial is contrasted by reduced or lacking ventilation during the deglaciation with minimum carbon isotope values during the Boelling-Alleroed and 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 a partial OMZ during these time intervals.

The mid-Holocene time interval is less ventilated than today and we suppose that formation of OSIW is diminished and sometimes ceases during this interval. From ca. 4 to 5 kyr 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 that today precondition the near-shore shelf regions for OSIW formation by brine rejection and enhanced winter mixing.

On a hemispheric scale, principal centennial to millennial-scale variability of temperature and OSIW ventilation coincides with some changes in NADW production throughout the Holocene. However, no one-to-one correlation is evident, pointing to distinctly different forcing mechanism and feedbacks for the two basins.