Long-term variation of remote reemergence of the North Pacific subtropical mode water

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The oceans are in general regarded as the most important component of the climate system, having a large thermal inertia compared with that of the overlying atmosphere. Air-sea interaction during one late winter creates sea surface temperature (SST) anomalies in a deep mixed layer (ML). When the ML shoals in spring, the thermal anomalies are stored under the shallow ML in summer, and are insulated from the atmospheric forcing. As the ML deepens again in the fall and the next early winter, waters having anomalies are re-entrained into the deeper ML, and the anomalies recur into the surface. In this way, SST anomalies recur at the sea surface in the next winter. This reemergence mechanism is noted as memorizing mechanism of winter SST anomalies. We detected seven reemergence areas in the world's oceans, and found that all the reemergence areas correspond to mode water formation areas. We named this type co-located reemergence. Further, we also pointed out an existence of remote reemergence of the North Pacific subtropical mode water (NPSTMW), reemergence area of which is different from the formation area. The remote reemergence area is actually located in the central North Pacific, i.e., just under the Aleutian Low.

Using long-term dataset (from 1930 to 2003) of SST, core-layer temperature (CLT) of the NPSTMW, and the North Pacific index (NPI) showing the Aleutian Low activity, we quantitatively investigate an impact of remote reemergence of NPSTMW on winter SST variation in the central North Pacific.

A running correlation analysis between CLT and SST in the remote reemergence area clearly shows that an occurrence of remote reemergence strongly depends on the specific period with approximately 20 years. During about 10 years, remote reemergence well works (occurrence period), while reemergence signal never appear at the sea surface during the next 10 years (non-occurrence period). It is found that this period-dependent nature of remote reemergence closely connects with the spin-up/spin-down of the North Pacific subtropical gyre, i.e., the Aleutian Low activity, with the lag of 6 to 8 years. Further, a multiple regression analysis for SST anomalies in the remote reemergence area is performed using two explanatory variables of NPI and CLT. It shows that this reemergence mechanism gives a significant impact on SST there, and the impact is an equivalent degree to the surface thermal forcing related with the Aleutian Low activity during the occurrence periods. It can be pointed out that CLT and NPI are major components controlling winter SST field in the central North Pacific. On the other hand, the Aleutian Low activity dominantly contributes to winter SST variation during non-occurrence period.

We think that since this reemergence mechanism can strongly affect winter SST variation in the central North Pacific, some feedback would work on the Aleutian Low activity. This reemergence may play an important role in the Pacific Decadal Oscillation.