Dynamics of North Pacific oceanic heat content variability on decadal time-scale

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Upper ocean heat content (OHC) is a widely monitored oceanic state variable for climate change. OHC signals are also at the heart of the decadal climate variability, carrying climate memory that may provide the source of the skill for decadal prediction. Thus, understanding of the generation and propagation of OHC is important. In the mid-latitude North Pacific Ocean, OHC signals are often found to propagate eastward as opposed to frequently-observed westward propagations of sea surface height, a similar variable to OHC representing the ocean subsurface state. We investigate this dichotomy using a 150-year CGCM integration. Simulated OHC signals are distinguished in terms of two processes that can support eastward propagation: higher baroclinic Rossby wave (RW) modes that are associated with density perturbation, and temperature and salinity anomalies that are density compensated, a.k.a. spiciness anomalies. Our analysis suggests a unique role of the Kuroshio/Oyashio Extension (KOE) region as an origin of the spiciness and higher mode RW signals as follows. First, wind-forced, westward-propagating first baroclinic RW causes circulation anomalies in the KOE region, accompanying the meridional shift of the subarctic front. Anomalous advection of mean temperature and salinity gradients then generates spiciness anomalies, which are advected eastward by mean currents. While being advected, the surface temperature anomaly associated with the spiciness signal is damped by air-sea heat exchange and thus generates density perturbation, which further propagates eastward as higher mode RWs. The result suggests that large OHC anomalies are associated with the spiciness gradients and axial variability of oceanic fronts.