In the western North Pacific, there are at least two prominent oceanic frontal zones between the subtropical and subarctic gyres, the Kuroshio Extension and subarctic (Oyashio-Extension) frontal zones. In those oceanic frontal zones, oceanic dynamics can induce variations in sea surface temperature, air-sea heat exchanges, and further these possibly modify storm track activity aloft and large-scale atmospheric circulation on interannual-to-decadal time scales. Improving our understanding of variations in these oceanic frontal zones and their mechanisms is thus important to understand the ocean and climate in midlatitudes. We have then investigated them based on a 60-year long eddy-resolving OGCM hindcast integration, which represents well those frontal structures and their interannual to decadal variations.

In the model, it is shown that although atmospheric variations have large horizontal scale, resultant oceanic variations have large amplitude with narrow meridional scale. For example, the Kuroshio Extension Current (KEC) speed has decadal variation, which can be explained by wind-driven Rossby wave propagation, but its frontal meridional scale cannot be directly explained by large-scale wind variations, suggesting some nonlinear processes included. Indeed, importance of advection of potential vorticity anomalies from the Izu Ridge region is suggested for the upper layer KEC variations, and importance of eddy potential vorticity flux is suggested for the deep northern recirculation gyre variation, which also relates to variations in the KEC. Probably due to some nonlinear process, this model also shows that the KEC has internal variations (independent of external forcing variations), which can induce uncertainty in the hindcast KEC variations.