

## Pathways of the North Pacific Intermediate Water identified through the tangent linear and adjoint codes of an OGCM

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We develop a strategy of tracing a target water mass, and apply it for analyzing the pathway of the North Pacific Intermediate Water (NPIW) from the subarctic gyre to the northwestern part of the subtropical gyre south of Japan in a simulation of an ocean general circulation model. This strategy estimates the pathway of the water mass that travels from an origin to a destination area during a specific period using a conservation property concerning tangent linear and adjoint models. In our analysis, a large fraction of the low salinity origin water mass of NPIW initially comes from the Okhotsk and Bering Seas, meets at the southeastern side of the Kuril Islands, and is advected to the Mixed Water Region (MWR) by the Oyashio current. It then enters into the Kuroshio Extension (KE) around the first KE ridge, and is advected eastward by the KE current. It, however, deviates southward from the KE axis around 158E over the Shatsky Rise, or around 170E on the western side of the Emperor Seamount Chain, and enters into the subtropical gyre. It is finally transported westward by the recirculation flow. This pathway corresponds well to the shortcut route of NPIW from MWR to the region south of Japan inferred from the analysis of the long-term freshening trend of NPIW observation.

Keywords: Adjoint, Sensitivity analysis, North Pacific Intermediate Water, Kuroshio Extension, Oyashio