Extreme Warming east of Japan tied to Multidecadal Cooling of the Tropical Pacific

*Baolan Wu[1,2], Shang-Ping Xie[3], Ayumu Miyamoto[3], Yu Kosaka[4], Toshio Suga[1], Fumio Inagaki[5,1]

1. Advanced Institute for Marine Ecosystem Change (WPI-AIMEC), Tohoku University, 2. Graduate School of Science, Tohoku University, 3. Scripps Institution of Oceanography, University of California San Diego, 4. Research Center for Advanced Science and Technology, The University of Tokyo, 5. Advanced Institute for Marine Ecosystem Change (WPI-AIMEC), Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Over the past three decades, increasingly frequent extreme marine heatwaves (MHWs) have occurred off the coast of northeastern Japan, accompanied by exceptionally rapid surface warming (>0.6 degC decade-1) in a broad zonal band of the North Pacific east of Japan, known as the Kuroshio-Oyashio Extension, far exceeding the global mean trend (~0.1 degC decade-1). These changes have caused severe environmental disruptions and substantial impacts on regional fisheries. Although several mechanisms have been proposed, their relative contributions and combined effects remain poorly quantified. By restoring tropical Pacific sea surface temperature toward observations, we demonstrate that a global coupled ocean-atmosphere model successfully reproduces the accelerated warming in the Kuroshio-Oyashio Extension. Our results show that multidecadal cooling in the tropical eastern Pacific excites large-scale atmospheric teleconnections that weaken the Aleutian Low, generating anticyclonic wind curl anomalies that force downwelling oceanic Rossby waves. These ocean-atmosphere adjustments induce a poleward expansion of the North Pacific subtropical gyre and pronounced surface and subsurface warming in the Kuroshio-Oyashio Extension. Whereas extreme warming events and MHWs are commonly attributed to anthropogenic global warming, our results highlight the critical role of internal ocean-atmosphere dynamics in shaping recent North Pacific climate extremes.

Keywords: Extreme Ocean Warming, Tropical Pacific Variability, Climate Teleconnection, Subtropical Gyre Expansion

