

Sea Level Variability in the Western North Pacific during the 20th Century

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Sea level variability in the western North Pacific during the 20th century and its relation to coastal sea level variability along Japan is examined by using observational data, a regional ocean model output, and the CMIP5 historical simulations. Two study periods are defined: One is from 1993 to 2010, when altimeter data provide detailed information of sea level variability, and the other period is from 1906 to 2010, when observational sea level data are severely limited. In the former period (1993–2010), the leading sea level variability in the western North Pacific is characterized by zonally elongated and meridionally narrow sea level anomalies in the Kuroshio Extension (KE), which results from the meridional shifts of the KE jet on decadal timescales. These meridional shifts are caused by westward propagating Rossby wave from the eastern North Pacific, which is concentrated along the KE jet axis as jet-trapped Rossby waves. The resulting sea level changes along the coast of Japan show a strong spatial contrast. The coastal sea level fluctuation is quite large along the southeastern coast of Japan that is under the direct influence of the jet-trapped Rossby waves, but is small north of the KE jet latitude. Hence, the nature of the wave trapped by the KE jet produces a “shadow zone” of coastal sea level variability along Japan. These results indicate that the correct representation of western boundary currents is necessary for reliable prediction of coastal sea level changes. In the latter period (1906–2010), the tide-gauge data and oceanic temperature observation data show the high coastal sea level along Japan around 1950, which is as large as the recent sea level. The regional model simulation reveals that this high sea level around 1950 is associated with the high sea level in the western North Pacific, and is largely induced by wind stress curl changes over the North Pacific, characterized by a weakening of the Aleutian Low. The multi-model ensemble mean sea level variability around Japan under the historical scenario does not show this high sea level around 1950. That the wind-induced sea level rise in the western North Pacific around 1950 highlights the importance of natural variability in understanding regional sea level change on interdecadal timescales.

Keywords: Kuroshio Extension, wind forcing, decadal variability