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Improvement of climatic mean state and variability over the western North Pacific by better representing oceanic fronts in a nested regional ocean model implemented into MIROC5

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We have developed a global climate model MIROC5 where a nested ocean model is implemented for the purposes of improving model climate, variability, and skills of seasonal to multi-year climate predictions in the western North Pacific (15°N–55°N, 115°E–180°E). Recently, based on analyses of observational data and modeling studies using atmospheric models, it has been revealed that sharp sea surface temperature (SST) fronts accompanied by swift oceanic western boundary currents affect atmospheric mean states and disturbances in the troposphere. In the present study, using the coupled model with the nested ocean model, influences of SST fronts on the overlying atmosphere are demonstrated. The horizontal resolutions of global atmospheric and oceanic models are a T85 spectral truncation and 0.5°, respectively. The nested regional ocean model has horizontal resolution of 0.1°. The model is driven by fixed external forcing under the pre-industrial conditions. In the Kuroshio-Oyashio confluence zone (KO zone), climatological wintertime SST is warmer and its meridional gradient is larger in the present simulation than in MIROC5 without the nested ocean model. These differences in the SST distribution are due to enhanced northward heat transport by the Kuroshio and its extension. Corresponding to the SST change in the KO zone, upward heat flux from the sea surface to the atmosphere is increased and this enhanced flux affects the free atmosphere above the marine atmospheric boundary layer. Over the KO zone, remarkable surface wind convergence and resultant upward wind at 500 hPa height occur and wintertime precipitation is increased clearly. At the same time, wintertime storm track activity is strengthened due to enhanced surface baroclinicity induced by the surface flux and energy conversion from mean potential energy to eddy potential energy. In summer, warm water transport by the Kuroshio south of Japan is larger and precipitation band along the Kuroshio and its extension is more clearly seen in MIROC5 with the nested model than in that without the nested model. Regarding the Japan Sea, the SST front associated with the East Korean Current is better represented in MIROC5 with the nested ocean model than in that without the nested model. As a result, warm biases in SST and the surface air temperature in the northern part of the Japan Sea are much improved.