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Projected Changes of East Asian Climate with a Regional Air-Sea Coupled Model: Does Regional Air-Sea Coupling Play a Role?

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A regional air-sea coupled model coupled (named FROALS) through OASIS3.0 was developed for CORDEX East Asia. The regional air-sea coupled model was composed of a regional climate model RegCM3 as its atmospheric component and a global climate ocean model (LICOM) as its oceanic component. The developed regional air-sea coupled model FROALS has been applied to CORDEX East Asia domain. Driven by the historical simulation and future climate projection under RCP scenario from a global climate system model, dynamical downscaling has been conducted at the uniformly horizontal resolution of 50 km. The impacts of regional air-sea coupling on the simulation and projection of East Asian summer monsoon rainfall have been investigated with comparisons to the corresponding standalone regional climate model (RCM) simulations. For present-day climate (1980-2005) simulation, the added value of FROALS with respect to the driving global climate was evident in terms of both climatology and interannual variability of summer rainfall over eastern China, contributing from both the high horizontal resolution and the reasonably simulated moisture fluxes convergence. Compared with the standalone RCM simulation, the spatial pattern of the simulated low level monsoon flow over East Asian-western North Pacific was improved in the FROALS due to the inclusion of regional air-sea coupling.
Changes in mean and interannual variability of summer rainfall were discussed for the period of 2051-2070 under RCP8.5 scenario with respect to the present day period of 1986-2005. Followed by an enhanced western North Pacific subtropical high and an intensified East Asian summer monsoon, an increase of total rainfall over North China, Korean Peninsula, and Japan but a decrease of total rainfall over southern China are seen in the projection of FROALS. Homogeneous increases of extreme rainfall amount were found over CORDEX East Asia. However, the atmosphere-only RCM exhibited too strong responses to the underlying SST warming anomalies, which induced an anomalous cyclone over North South China Sea and followed by an increases (decreases) of total and extreme rainfall over southern China (central China). The differences of the projected changes in both rainfall and circulations between FROALS and the atmosphere-only RCM were partly affected by the differences in the projected SST changes. The results recommend the employment of regional ocean-atmosphere coupled model in the dynamical downscaling of climate change over CORDEX-East Asian domain.