

Understanding the effect of excessive cold tongue bias on the projections for the tropical Pacific SST warming pattern

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The excessive cold tongue is a common bias among current climate models, which has been considered as an important source of bias for future tropical Pacific climate change projections under global warming. Especially, the excessive cold tongue bias is closely related to the tropical Pacific SST warming (TPSW) pattern. In this study, we reveal that two processes are the critical mechanisms by which the excessive cold tongue bias influences the projection of TPSW pattern based on 32 models from phase 5 of Coupled Model Inter-Comparison Projection (CMIP5). On one hand, the excessive cold tongue bias can induce an overly weak negative shortwave (SW)–SST feedback in the central Pacific, which can lead to a positive SST warming bias in the central to western Pacific. Moreover, the overly weak local atmospheric dynamics response to SST is a key process of the overly weak SW–SST feedback, compared with the cloud response to atmospheric dynamics and the SW response to cloud. On the other hand, the over-strong ocean zonal overturning circulation associated with the excessive cold tongue bias overestimates the ocean dynamical thermostat effect with the enhanced ocean stratification under global warming, leading to a negative SST warming bias in the central and eastern Pacific. These two processes jointly form a positive SST warming bias in the western Pacific, contributing to a La Niña-like warming bias. Therefore, we suggest a more realistic climatological cold tongue SST is needed to a more reliable projection for the TPSW pattern.

Keywords: cold tongue bias, tropical Pacific SST warming pattern, SW-SST feedback, ocean dynamics

