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Editorial: Early career scientists' contributions to tropical Pacific Ocean dynamics and its interaction on mid-latitude weather and climate: features, mechanisms, and prediction

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Editorial on the Research Topic
Early career scientists' contributions to tropical Pacific Ocean dynamics and its interaction on mid-latitude weather and climate: features, mechanisms, and prediction

The tropical Pacific Ocean hosts various modes of climate variability, including the El Niño Southern Oscillation (ENSO). As the Earth's strongest source of interannual climate variability, the impact of ENSO extends to ocean-atmosphere circulations and weather patterns across the globe. While a lot is now known about the physical understanding of the general ocean and atmospheric teleconnection of tropical Pacific climate variability, significant gaps remain regarding its impact on weather and climate processes, particularly outside the tropical Pacific, as well as bio-geochemical compositions including the global carbon cycle (Betts et al., 2020; Goddard and Gershunov, 2020; Kug et al., 2020; Lin et al., 2020; Sprintall et al., 2020; Taschetto et al., 2020). This is due in part to persistent deficiencies in modeling ocean-atmosphere-climate processes. Improving knowledge of some fundamental physics of the tropical Pacific Ocean and its link on mid-latitude variability, in particular, is required to advance climate modeling and prediction. This includes advancing the knowledge on interactions between the tropical Pacific variability with remote regions through oceanic and atmospheric teleconnection (Pacific Ocean-Indian Ocean, Pacific Ocean-Atlantic Ocean, interaction with high-latitude climate such as the Arctic) on a broad range of timescales.

Here the impact of tropical Pacific Ocean variability on global ocean and climate variability is featured, ranging from the impact of ENSO on atmospheric circulation and

chemistry over the North Atlantic European region, to the impact of tropical sea surface temperature (SST) variability on Northern Hemisphere climates, western north Pacific cyclones, and Indian Ocean circulation.

To this end, Liu et al. discussed the "ENSO teleconnection to interannual variability in carbon monoxide (CO) over the North Atlantic European region in spring". The study founds an increase/decrease tropospheric CO concentration over the North Atlantic European region (NAE) in the following spring (March to May) of El Nino/La Nina winter (November to February). Analysing the observed fire emissions and atmospheric conditions, combined with tagged CO simulations by the chemical transport model, GEOS-Chem (Goddard Earth Observing System-Chemistry) they further concluded that this teleconnection is the combined effects of ENSO on both biomass burning and atmospheric transport. On the other hand, Lin et al. evaluated "The impact of tropical SST variability on the northern hemisphere circum-global teleconnection pattern". Using the Community Earth System Model "peacemaker" experiments, they showed that the summer Circumglobal Teleconnection, which strongly influence the mid latitude weather, is mainly forced by the Indo-western Pacific SST variability. These two studies reaffirmed the important remote impact of tropical Pacific Ocean on weather and climate variability in other regions (North Atlantic European region, northern hemisphere) and thus better representation of tropical-extratropical teleconnection in model necessary to accurate seasonal forecasts. Their results also suggest that the increased risk of ENSO-related extremes, such as drought, floods, could be detectable in the mid-latitude in the coming decades under global warming condition.

Liu et al. evaluated "The impacts of model resolution on responses of western North Pacific tropical cyclones (TC) to ENSO in the HighResMIP-PRIMAVERA" (High Resolution Model Intercomparison Project-Process-Based Climate Simulation: advances in High-Resolution Modelling and European Climate Risk Assessments) ensemble. They showed that the High Resolution (HR) models outperform the Low Resolution (LR) ones in reproducing the observed increase of TC genesis frequency in the southeastern Western North Pacific (WNP), but the decrease in the northwestern WNP in the developing years of El Niño. The better performance of HR than LR models is due to the generally increased frequency and variability of TC in the HR models. On the other hand, the difference between El Niño teleconnection to the WNP in the HR and LR models shows a dipole circulation difference between the HR and LR models with an anomalous cyclone in the southeastern WNP and anticyclone in the northwestern WNP, which enhances the dipole TC genesis anomalies in the HR compared to the LR models. The teleconnection difference is mainly related to the westward shift of the ENSO-related SST and convection anomalies in the tropical Pacific in the HR compared to the LR models, which may be ultimately linked to the reduced cold tongue biases in the HR models. Their study indicates that possible influences of the model resolution need to be considered when interpreting the climate effects of ENSO using climate models. Sustained efforts are needed to understand the origins of and to reduce the model biases for better simulation, prediction and projection of our climate systems.

Zhang and Mochizuki discussed the decadal modulation of ENSO and IOD (Indian Ocean Dipole) on Indian Ocean upwelling using observational diagnosis and advanced statistical tools. They found that the IOD impact on the eastern Indian Ocean upwelling shifts by modulating the ocean stratification and surface wind forcing after 1980s than in previous decades. The ENSO impact on the western Indian Ocean upwelling is also decadally modulated mainly due to differences in the dominant ENSO patterns linked to Pacific Decadal Oscillation phase. This work implies that background change in mean state and diversity of ENSO events need to be considered when discussing the interaction between tropical Pacific Ocean and other basins.

Tropical Pacific Ocean variability plays a crucial role in climate variability in other basins. Significant progress has been made in terms of observation, theories and modelling. However, significant efforts are still needed to improve the simulations and the understanding of physical mechanisms, processes, and predictability of the tropical Pacific climate and its impact on remote climate variability and weather patterns in various regions for all seasons.

Author contributions

XZ: Writing–original draft, Visualization, Conceptualization. AS: Writing–review and editing, Visualization, Supervision. TM: Writing–review and editing, Visualization, Supervision. SC: Writing–review and editing, Visualization. ZJ: Writing–review and editing, Visualization.

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Publisher's note

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