Researchers reveal rainfall response over the Indian Ocean under 'carbon neutrality' scenario

November 4 2021, by Li Yuan

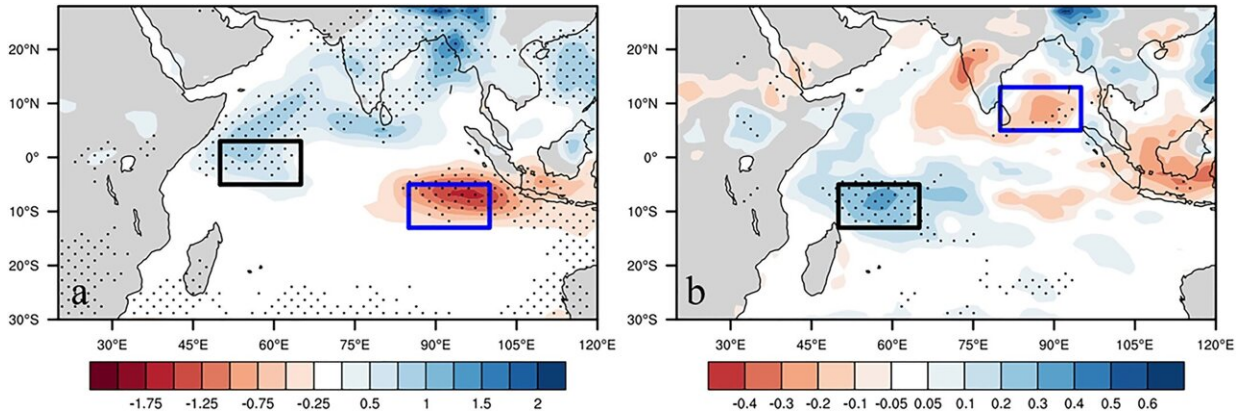

Fig. 1. The responses of rainfall (units: mm d^{-1}; color shading) during the radiative forcing (RF) increase (a) and stabilization (b). Stippling indicates that more than 80% of the models (10 out of 13) agree on the sign of the multi-model ensemble (MME) results. The black and blue boxes in panels (a, b) are used for diagnostic analysis of the sea surface temperature (SST) pattern in Section 3.3 and Figure 11.

Since the industrial revolution, more and more energy has been stored in the climate system because of human activity. About 93% is absorbed by global ocean. Heat is transmitted from the ocean surface to the deep ocean through thermal diffusion or other dynamical processes in the ocean, causing the deep ocean to warm, which in turn affects climatic

system.

Previous studies mainly focused on the impact of the increase in atmospheric CO_2 concentration, as well as the role of the surface ocean heat absorption, on climate. However, both the 2015 Paris Agreement and "carbon neutrality" policy, require CO_2 concentration to be reduced or stabilized. Under this scenario, deep ocean warming plays a more crucial role.

The Indian Ocean (IO) is an important moisture source of the East Asian monsoon. A research team from the Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences investigated the Indian Ocean rainfall, and found that it nearly displays reversal responses during the increase and stabilization of CO_2 concentration.

They found that when the CO_2 concentration increased, the rainfall enhanced over the tropical North Indian Ocean and declined over the southeastern Indian Ocean; meanwhile, under the "carbon neutrality" scenario, the rainfall displayed a different response pattern, with decreasing over the northeastern Indian Ocean but increasing over the southwestern Indian Ocean. Changes in atmospheric circulation (the dynamic component) mainly accounted for this dipole responses of rainfall.

It was further related to the sea surface temperature (SST) pattern, agreeing with the "warmer-get-wetter" mechanism. Under the "carbon neutrality" scenario, anomalous SST over the Indian Ocean showed south-north dipole. This is a result of the changes in ocean heat transport caused by changes of meridional temperature, transporting warmer water from middle/high latitudes to lower latitudes.

The SST responses over the Southern Ocean are the consequences of the weakening of meridional overturning circulation led by the changes of

ocean stratification. This research showed that different pathways of CO_2 concentration may lead to different rainfall responses over the Indian Ocean, and that these climatic feedbacks are related to deep ocean warming.

"In order to reduce climate risk, human society is trying to limit greenhouse gas emissions. Our study suggests that the increase or stabilization of CO_2 concentration may have different effects on climate. This has profound implications for understanding the mechanisms of climate change," said the corresponding author Prof. HUANG Gang from IAP.

The study is published in *Earth's Future*.

More information: Hongyu Hou et al, Reversal Asymmetry of Rainfall Change Over the Indian Ocean During the Radiative Forcing Increase and Stabilization, *Earth's Future* (2021). DOI: 10.1029/2021EF002272

Provided by Chinese Academy of Sciences