Counteracting effects on ENSO due to ocean chlorophyll interannual variability and instability in the tropical Pacific

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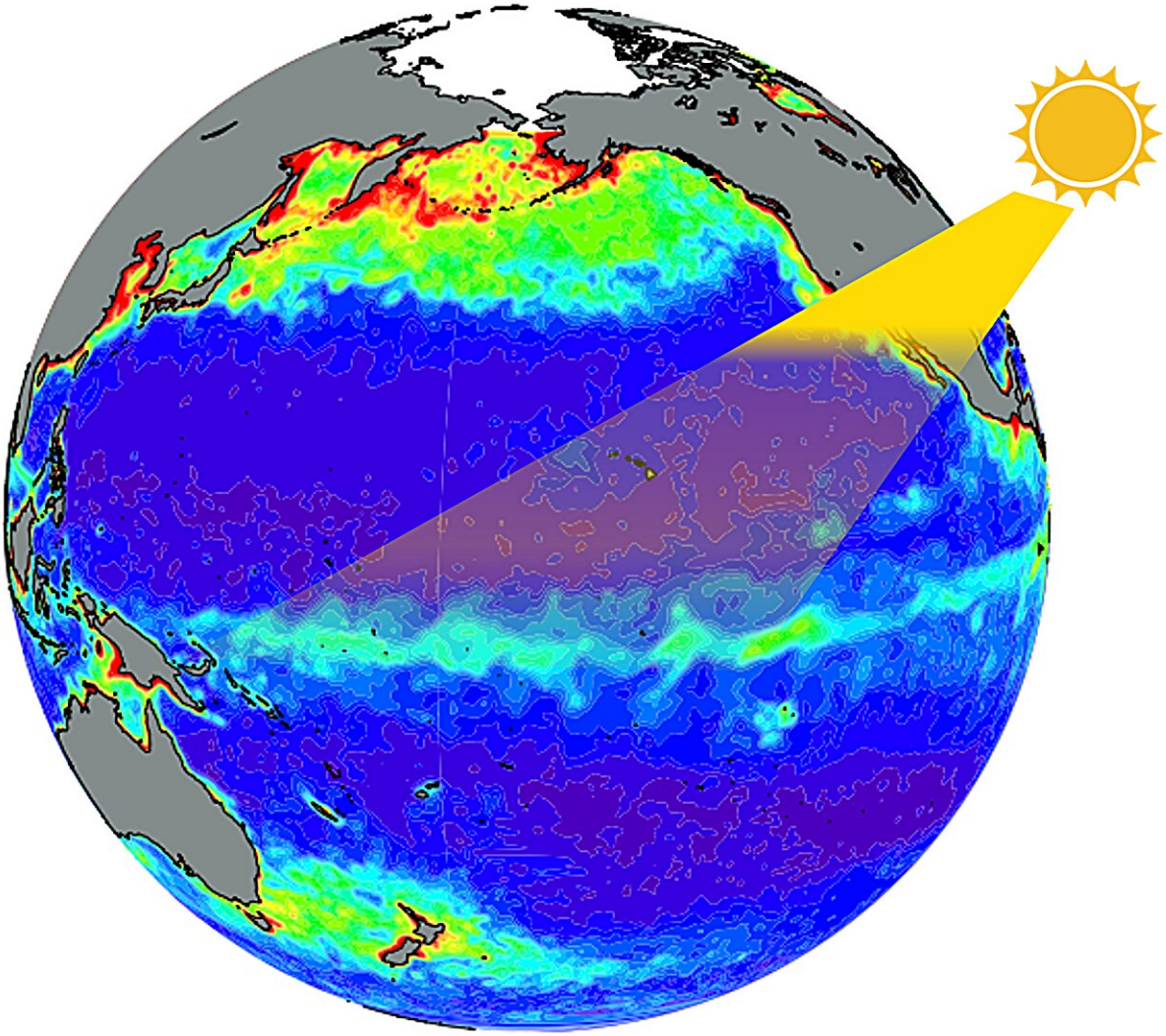


In the autumn of 2010, a La Niña event is formed in the tropical Pacific, characterized by a high Chl concentration. At the same time, tropical instability waves (TIWs) are active, which gives rise to large CHL perturbations as clearly observed in the eastern-central equatorial Pacific. These multiscale CHL perturbations exert effects on penetrative solar radiation in the upper ocean. Credit: Science China Press

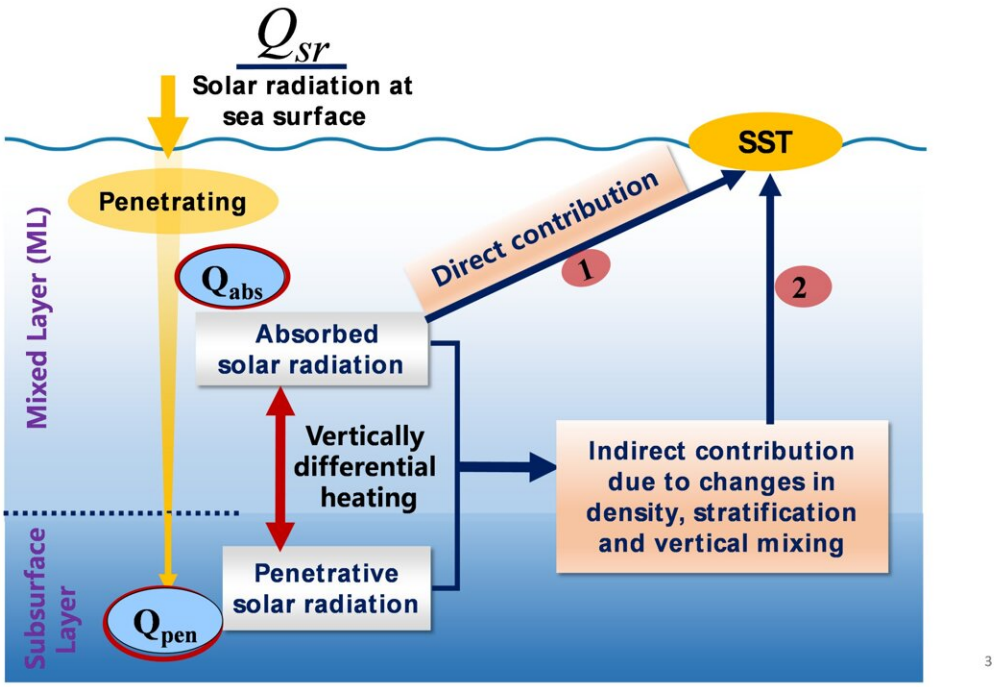
In as study published in the journal *Science China Earth Sciences* and led

by Prof. Rong-Hua Zhang (School of Marine Sciences, Nanjing University of Information Science and Technology), large perturbations in chlorophyll (Chl) were observed to coexist at interannual and tropical instability wave (TIW) scales in the tropical Pacific.

"At present, their combined effects on El Niño-Southern Oscillation (ENSO) through ocean biology-induced heating (OBH) feedbacks are not understood well," Zhang says.

Zhang and his coworkers adopted a hybrid coupled model (HCM) for the atmosphere and ocean physics-biogeochemistry (AOPB) in the tropical Pacific to quantify how Chl perturbations can modulate ENSO at interannual and TIW scales, individually or collectively, respectively.

The team found that the HCM-based sensitivity experiments demonstrate a counteracting effect on ENSO: the bio-climate feedback due to large-scale Chl interannual variability acts to damp ENSO through its impact on upper-ocean stratification and vertical mixing, whereas that due to TIW-scale Chl perturbations tends to amplify ENSO.



Ocean chlorophyll can exert a direct impact on sea surface temperature (SST) within the oceanic mixed layer and an indirect impact on the stratification and mixing intensity in the upper ocean; the relative strength of the two determines the change in direction of sea surface temperature responses. Through these processes shown in this figure, the interannual- and TIW-scale chlorophyll perturbations tend to weaken and enhance the amplitude of ENSO, respectively. Credit: Science China Press

The researchers also illustrated that because ENSO simulations are sensitively dependent on the ways Chl effects are represented at these different scales, it is necessary to adequately take into account these related differential Chl effects in climate modeling. A bias source for ENSO simulations is illustrated that is related to the Chl effects in the tropical Pacific, adding new insight into interactions between the climate system and ocean ecosystem on different scales in the region.

"These new exciting results reveal a level of complexity of ENSO modulations resulting from Chl effects at interannual and TIW scales, which are associated with ocean biogeochemical processes and their interactions with physical processes in the tropical Pacific," Zhang says.

More information: Rong-Hua Zhang et al, Counteracting effects on ENSO induced by ocean chlorophyll interannual variability and tropical instability wave-scale perturbations in the tropical Pacific, *Science China Earth Sciences* (2023). DOI: 10.1007/s11430-023-1217-8

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