Unexpected limitation of tropical cyclone genesis by subsurface tropical central-north Pacific during El Niño

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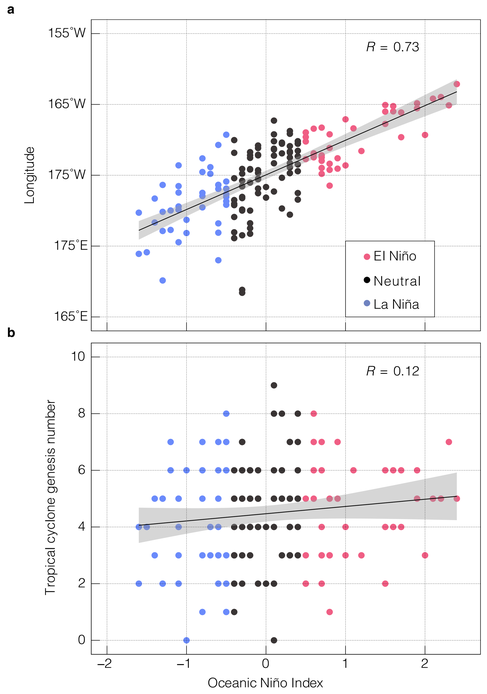
Introduction



The western Pacific warm pool expands during El Niño, but the tropical cyclone (TC) genesis number remains unchanged.

Methods

$$\mathrm{GPI}_{\mathrm{ocean}} = p|10^5\eta_{1000}|^f \left(\frac{\bar{T}}{26}\right)^g \left(\frac{F}{45}\right)^h \left(\frac{D_{26}}{80}\right)^i$$ Genesis potential index

the absolute vorticity at 1000 hPa;

the mean temperature in the upper mixed layer;

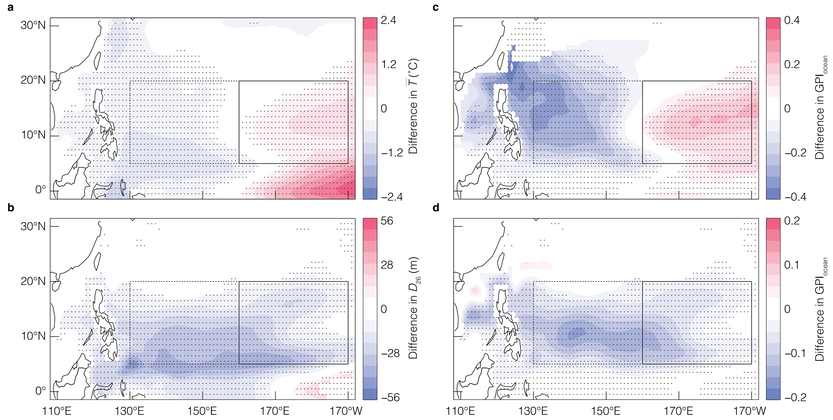
the net longwave radiation at the sea surface;

the depth of 26˚C isotherm.

$$\triangle\mathrm{GPI} = \frac{\partial \mathrm{GPI}}{\partial \eta_{1000}} \bullet \triangle\eta_{1000} + \frac{\partial \mathrm{GPI}}{\partial \bar{T}} \bullet \triangle\bar{T} + \frac{\partial \mathrm{GPI}}{\partial F} \bullet \triangle F + \frac{\partial \mathrm{GPI}}{\partial D_{26}} \bullet \triangle D_{26}$$

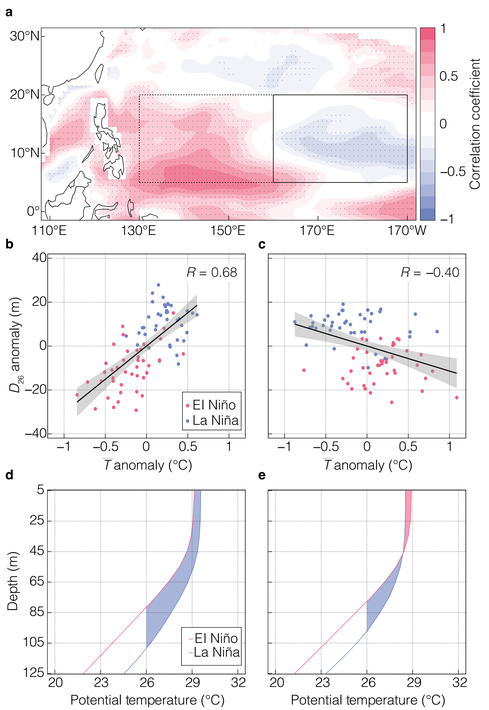
The total change can be divided into contributions of each variable.

Results



Differences of the upper mixed layer and 26 °C isotherm depth between the two phases of ENSO and their impacts on tropical cyclone genesis (GPI).

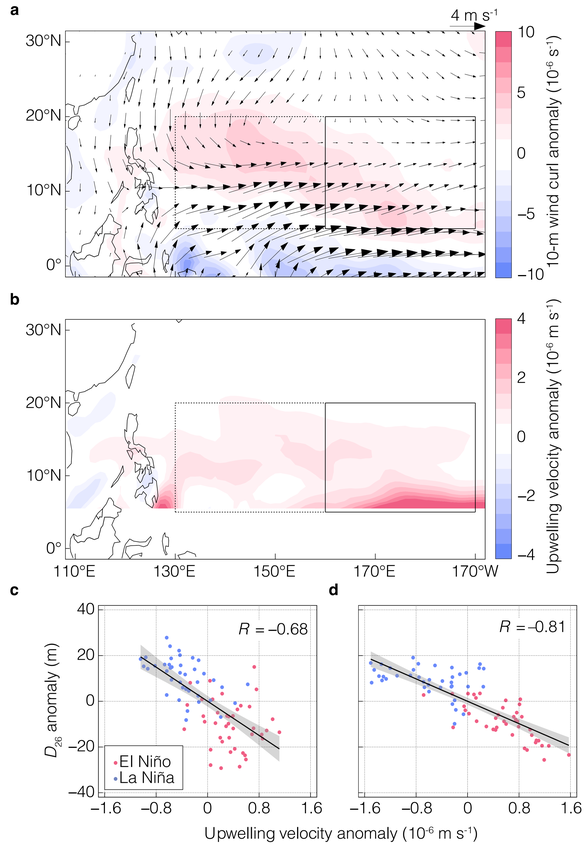
Negative correlation between D26 and SST in central-north Pacific



The traditional positive correlation between SST anomalies and the 26 °C isotherm depth exists over much of the tropical oceans, which is dynamically established by the first baroclinic mode in the ocean. Nevertheless, the tropical central-north Pacific (solid box) during ENSO is an exception.

Therefore, the reduced heat content as well as the shallow D26 in the tropical central Pacific result in an unexpected limitation on the TC genesis suggesting a delicate yet competing control between SST and the subsurface heat content in jointly modulating TC genesis.

Conclusions



This negative correlation between SST and 26 °C isotherm depth anomalies is opposite to the positive correlation in the tropical eastern and western Pacific. This is critical because quantifying the dynamics of the subsurface ocean provides insight into TC genesis.

The trend in TC genesis continues to be debated. Future projections must account for the net effect of the surface-subsurface dynamics on TCs, especially given the expected El Niño-like pattern over the tropical Pacific under global warming.

Gao, C., Zhou, L., Wang, C. et al. Unexpected limitation of tropical cyclone genesis by subsurface tropical central-north Pacific during El Niño. Nat Commun 13, 7746 (2022).