Warming Sea Surface Temperature Raises the Bar for Tropical Cyclogenesis

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The response of tropical cyclones to enhanced atmospheric CO_2 concentrations remains an open question. Here, we break this problem into its component parts and examine the response of deep tropical convection to sea surface temperature (SST) changes. Five fully coupled atmospheric-ocean general circulation models (AOGCMs), spanning a large range of climate sensitivities, are analyzed. Relationships between SST and deep tropical convection are evaluated for three climate states: present-day, doubled-CO_2 and quadrupled-CO_2.

Observations reveal a tropical convection threshold response to SST. We demonstrate that this SST threshold for convection varies seasonally and regionally and is associated with large-scale changes in the atmospheric structure. The atmospheric response is critical, since the integrated effects of the SST and atmospheric changes are together modulating the local tropical cyclogenesis potential.

Under present-day CO_2 concentrations, all AOGCMs capture the observed relationship between deep tropical convection and SST: deep convection occurs above a SST threshold of 25-26°C. Changes to tropical cyclogenesis associated with increasing levels of CO_2 are tied to the response of this SST threshold for tropical convection to the resultant global warming. Local tropical cyclogenesis potential will be modulated further by the atmospheric response to SST identified in the observations above. As CO_2 concentrations increase and the tropical SST warms, the threshold SST for deep tropical convection also warms. Consequently, no significant change is detected in regions amenable to tropical cyclogenesis.