What warms the warmest waters during El Niño?

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During El Niño, the upwelling in the eastern equatorial Pacific (EEP) slows, leading to a warm sea surface temperature (SST) anomaly, and the tropical troposphere warms. Only SSTs in regions with atmospheric deep convection, typically the warmest SSTs, affect the temperature of the tropical free troposphere. The warming of the EEP, which is home to the coldest tropical SSTs and does not experience atmospheric convection, therefore appears insufficient to explain the observed warming of the troposphere. Here, we examine the physical processes that lead to the warming of the warmest SSTs using both a global atmosphere-ocean coupled climate model and the ECMWF reanalysis. We show that SSTs in convecting regions do not warm as a result of ocean dynamics (upwelling), but as a result of a net heat flux from the atmosphere to the ocean following a weakening of surface winds and decrease in evaporation. This increased ocean heat uptake in convecting regions opposes the decrease in ocean heat uptake in the rest of the tropics during El Niño. This process may be important for linking surface temperature to ocean heat uptake changes, and the contribution of internal variability in the form of ENSO and IPO to the forced response observed over the historical record.