Anomalous SST trends 1979-present: Internal variability or systematic climate model forced response bias?

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Observed surface temperature trends over recent decades are characterized by (i) intensified warming in the Indo-Pacific Warm Pool and slight cooling in the eastern equatorial Pacific, consistent with strengthening of the Walker circulation, and (ii) cooling in the Southern Ocean. In contrast, state-of-the-art coupled climate models generally project Walker circulation weakening, enhanced warming in the eastern equatorial Pacific, and warming in the Southern Ocean. Here we investigate the ability of 16 climate model large ensembles to reproduce observed sea-surface temperature and sea-level pressure trends over 1979–2020 through a combination of externally forced climate change and internal variability. We find large-scale differences between observed and modeled trends that are very unlikely (<5% probability) to occur due to internal variability as represented in models. With only a single realization of the real climate system, it remains difficult to robustly identify the forced response in observations, meaning that these trend differences could result either from systematic model biases in the transient response to historical forcing or from model biases in the amplitude or pattern of multi-decadal variability. However, disparate trends are found even in regions with weak multi-decadal variability, suggesting that model biases in the transient response to anthropogenic forcing constitute part of the discrepancy. Regardless of whether the differences in observed and modeled trends results from internal variability or biases in the response to forcing, uncertainty in the timing and magnitude of eventual warming in delayed warming regions such as the East Pacific and Southern Ocean constitutes a leading order uncertainty in projected changes in the large-scale atmospheric circulation and regional climate.