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Cross-spectral analysis of the SST/10-m wind speed coupling resolved by satellite products and climate model simulations

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Abstract

This study aims to determine the spatial–temporal scales where the SST forcing of the near-surface winds takes places, and its relationship with the action of coherent ocean eddies. Here, cross-spectral statistics are used to examine the relationship between satellite-based SST and 10-m wind speed (w) fields at scales between 10^2–10^4 km and 10^1–10^3 days. It is shown that the transition from negative SST/w correlations at large-scales to positive at oceanic mesoscales occurs at wavelengths coinciding with the atmospheric first baroclinic Rossby radius of deformation; and that the dispersion of positively-correlated signals resembles tropical instability waves near the equator, and Rossby waves in the extratropics. Transfer functions are used to estimate the SST-driven w response in physical space (w_c), a signal that explains 5–40% of the mesoscale w variance in the equatorial cold tongues, and 2–15% at extratropical SST fronts. The signature of ocean eddies is clearly visible in w_c, accounting for 20–60% of its variability in eddy-rich regions. To provide further insight on the role of ocean eddies in the SST-driven coupling, the analysis is repeated for two climate model (CCSM) simulations using ocean grid resolutions of 1° (eddy-parameterized, LR) and 0.1° (eddy-resolving, HR). The lack of resolved eddies in LR leads to a significantly underestimated mesoscale w variance relative to HR. Conversely, the w_c variability in HR can exceed the satellite estimates by a factor of two at extratropical SST fronts and underestimate it by a factor of almost six near the equator, reflecting shortcomings of the CCSM to be addressed in its future developments.