Processes Shaping the Time-Mean Surface Wind Convergence Patterns Aound the Kuroshio Extension and Gulf Stream in Winter

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High-resolution satellite observations and numerical simulations have revealed that climatological-man surface wind convergence and precipitation are enhanced locally around the midlatitude warm western boundary currents (WBCs) with divergence slightly to the poleward. While steep sea-surface temperature (SST) fronts along the WBCs have been believed to play an important role in shaping those frontal-scale atmospheric structures, the mechanisms and processes involved are still under debate. The present study explores specific daily-scale atmospheric processes that are essential for shaping the frontal-scale atmospheric structures around the Kuroshio Extension (KE) and Gulf Stream in winter, taking advantage of a new product of global atmospheric reanalysis. Cluster analysis and case studies reveal that a zonally-extending narrow band of surface wind convergence frequently emerges along the KE, which is typically observed under the surface northerlies after the passage of a developed synoptic-sale cyclone. Unlike its counterpart around the cyclone center and associated cold front, the surface convergence is in moderate strength and persistent. Nevertheless, the moderate convergence accompanies ascent and convective precipitation. The band of convergence is a manifestation of a weak stationary atmospheric front anchored along the SST front or generation of a weak meso-alpha scale cyclone. Latent heating through convective processes induced by surface convergence play an important role in shaping the frontal-scale atmospheric structures by acting to reinforce the ascent and convergence. The Gulf Stream region exhibits similar characteristics, while the contribution from meso-alpha scale cyclones seems to be less dominant.

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