Thermally-direct, local atmospheric circulations over oceanic fronts in midlatitudes

*西井 和晃[1]、田口 文明[2,3]、吉田 聡[4]、中村 尚[2,3]、小坂 優[2]、宮坂 貴文[2]
*Kazuaki Nishii[1], Bunmei Taguchi[2,3], Akira Kuwano-Yoshida[4], Hisashi Nakamura[2,3], Yu Kosaka[2], Takafumi Miyasaka[2]

1. 三重大学大学院生物資源学研究科、2. 東京大学先端科学技術研究センター、3. 海洋研究開発機構、4. 京都大学
1. Graduate School of Bioresources, Mie University, 2. RCAST, University of Tokyo, 3. JAMSTEC, Japan, 4. Kyoto University

In the zonal average, a thermally indirect circulation (the Ferrel cell) is dominant in the midlatitude atmosphere in association with eddies. Cool (warm) air appears to ascend (descend) at higher (lower) latitudes. In this study, we found local, thermally-direct circulations just over midlatitude oceanic fronts (the Kuroshio Oyashio extension and Gulf Stream), which accompany steep meridional gradient of sea surface temperatures, in reanalysis data sets and an atmospheric global circulation model (AGCM) around the latitudes of downward branch of the Ferrel cell. Specifically, air rises (sinks) to the equatorward (poleward) of the oceanic fronts in association with diabatic heating. Equatorward ageostrophic wind is observed at the near surface over oceanic fronts to satisfy mass balance. In a set of AGCM experiments, one forced with a satellite-observed SST and the other where oceanic fronts in the prescribed SST field are horizontally smoothed out, the thermally direct circulation in the former is stronger than in the latter due to increase (reduction) of precipitation and the associated diabatic heating to the equatorward (poleward) of oceanic fronts. The experiments suggest that the near-surface equatorward ageostrophic wind leads to acceleration of surface easterlies through the Coriolis force in the presence of front, counteracting westerly acceleration due to anomalous westerly momentum convergence in association with enhanced storm track activity due to oceanic fronts. Therefore, oceanic fronts act to weaken near-surface westerlies just above them through intensifying local, thermally-direct circulations.

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