

Impact of the Kuroshio front on frontal structure of an extratropical cyclone associated with heavy precipitation

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It is well known that sea surface temperature (SST) fronts associated with warm ocean currents create horizontal thermal gradients in the near-surface atmosphere in the mid-latitudes. These thermal gradients may affect frontal structure of extratropical cyclones passing near warm currents. Moreover, fronts influenced by the mid-latitude ocean may be related to the occurrence of heavy precipitation. To answer these questions, we examined the impact of the SST front along the Kuroshio Current (Kuroshio front) on the frontal structure of an extratropical cyclone associated with heavy precipitation by utilizing observational data, objective analysis data, and regional cloud-resolving numerical experiments. This study paid special attention to an extratropical cyclone and related heavy precipitation on Miyake Island in early January 2017. When the cyclone intensified around the Kuroshio front, two surface fronts developed around the cyclone center. One was a warm front. The other was a non-classic front, which was called the outer front in this study, forming on the northern side of the warm front. A line-shaped precipitation band and a comma head-shaped precipitation band appeared along the outer front and along the bent-back warm front, respectively. During the passage of these bands, heavy precipitation was observed on Miyake Island. Looking at the evolution of the outer front, we found that it was located just along the Kuroshio front in its early life. During the formation stage of the incipient outer front, sensible heat supply was evident from the Kuroshio Current, whereas it was small on the northern side of the oceanic front. This meridional difference in sensible heating caused frontogenesis along the Kuroshio front, which led to the initial formation of the front. Thus, the Kuroshio front played an important role in the formation of the incipient outer front, contributing to the occurrence of the heavy precipitation.

Keywords: extratropical cyclone, Kuroshio, heavy precipitation