Changes in the distribution of thunderbolt over the sea caused by the Kuroshio large meander

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Most of the previous studies on thunderbolt in Japan have been case studies, and there have been few studies from a climatological perspective. In addition, most of the studies have been conducted on land-based thunderbolt, and only a few have been conducted on maritime thunderbolt. One of them, Iwasaki (2014), showed the average distribution of thunderbolt from 2009 to 2012. However, this study did not examine the long-term changes. In recent years, the Kuroshio large meander has been occurring, and the resulting changes in sea surface temperature have an impact on the atmosphere. In addition, it has been pointed out that the masses of warm and cold water generated during the meander contribute to extreme weather events in coastal areas. From these previous studies, it is expected that the Kuroshio large meander will affect the distribution of thunderbolt. However, there are no studies that have examined the effects of the Kuroshio large meander on thunderbolt. Therefore, in this study, we focused on the Kuroshio large meander and examined how it changes the distribution of thunderbolt in the sea around Japan. As the thunderbolt data around Japan, we used the high-resolution monthly average number of thunderbolt data provided by Franklin Japan Corporation. In this study, 2011-2016 is the non-major meander period and 2018-2020 is the major meander period, and for each variable, the ratio of the major meander to the non-major meander period and the difference between the annual means were calculated. The monthly trends of the variables averaged over the entire region, warm-core ring, and cold water mass during the major meander and non-major meander periods are also discussed.
The ratios of the thunderbolt distribution during the large meander and non-meander periods show that during the large meander period, the number of thunderbolt increased by more than five times in warm-core ring and decreased by less than one-half in cold water mass compared to the non-meander period. Looking at the differences in other variables, almost all variables showed an increase in warm-core ring and a decrease in cold water mass, but there was no clear difference in precipitation. The monthly changes in the number of thunderbolt during large meanders and non-major meanders showed that the number of thunderbolt during large meanders was higher than that during non-major meanders in summer for all regions, and was about the same in winter. In the warm-core ring, the number of thunderbolt increased about 15 times in October during the large meander. Considering the results of annual averages, the number of thunderbolt in cold water mass should have decreased during large meander, but increased in September, October and November. The number of thunderbolt on land is proportional to the product of precipitation and CAPE, but the ratio of precipitation×CAPE during large meander and non-meander is different from the result of the number of thunderbolt. However, the ratio of precipitation×CAPE during large meander and non-meander is different from that of the number of thunderbolt. The difference is especially pronounced in warm-core ring, suggesting that there may be a different environment for thunderbolt than on land.
In this study, we showed that the Kuroshio large meander may increase or decrease the number of thunderbolt in warm-core ring and cold water mass, respectively. The causes can be discussed as follows. In the warm-core ring, sea surface temperature and surface air temperature rise, and wind speed increases, causing heat and water vapor transport from the sea to the atmosphere to become more active. As a result, rising air current is strengthened, and it is thought that the environmental field where thunderbolt are likely to occur is created. In cold water mass, the opposite process occurs. In addition, the ratio of large meander to non-maander in warm and cold water mass does not agree with the number

of thunderbolt and precipitation×CAPE, which shows the importance of understanding the principle of thunderbolt over the sea.

Keywords: thunderbolt, Kuroshio large meander

