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Seasonal difference in relationship between the sea surface heat flux in the Kuroshio Extension region and the North Pacific Index

Hiroshi Ichikawa[†];
[†] JAMSTEC/Japan, Japan
Leading author: ichikawah@jamstec.go.jp

In mid- and high-latitude regions, various kinds of oceanic and atmospheric variables have annual signals much more dominant than interannual variations while their seasonal values change year by year. It has been well understood that seasonal values in the mean annual signals are dominated by other elements through seasonal time scale land-air-sea interaction processes. There is a possibility that, when annual signal is much larger than interannual variations, also the year-to-year changes of seasonal values are dominated by other elements through seasonal time scale land-air-sea interaction processes of which directions and magnitudes may change with respect to season. In this study, for better understanding of the mechanism underlying the year-to-year changes of seasonal values of oceanic and atmospheric variables, we examine, as the first step, the relationship between seasonal values in annual period components of the net heat flux (HFN) in the Kuroshio Extension region and the intensity of the Aleutian Low pressure represented by the North Pacific Index (NPI), the North Pacific area-weighted sea level pressure over the region of 30N-65N and 160E-140W. Monthly mean HFN used in this study is area mean of satellite-derived HFN at 10 x 6 grid points with 1-degree interval in the Kuroshio Extension region of 32.5N-38.5N and 142.5E-152.5E, in the data set called J-OFURO2 over the global ocean during 20 years from January 1988 to December 2007. Annual period component of HFN, HFNan, from January 1989 to December 2006 is calculated by extracting HFN12 (calculated at each month by repeating twice the 13-points averaging) from HFN03 (calculated at each month by repeating twice the 3-point averaging). Annual period component of NPI, NPIan, is calculated by the same method as for HFNan. Owing to a shortage of available common data duration length of 216 months, the seasonal differences of relationship between HFNan and NPIan are examined by lagged correlations between them, e.g., lagged correlation between HFNan in January and NPIan in March after 14 months, is calculated as covariance between HFNan in January from 1989 to 2005 and that of NPIan in March from 1990 to 2006. HFNan in January is estimated to have statistically significant correlation maxima with those of NPIan in February before 35 months, in August before 29 months, and in May after 16 months. However, two of these three correlation maxima are found not to represent direct relation. After rejecting such false correlation maxima, eight correlation maxima are fixed as representing direct relations between HFNan and NPIan for various months in the year. Among them, HFNan in January has the largest statistically significant positive correlation of 0.815 with NPIan in August before 29 months. This relation suggests that the variations of atmospheric circulation over the Northern hemisphere associated with NPI in summer affects strongly the amount of HFN in the Kuroshio Extension region in the third winter through some land-air- ocean interaction processes. It is found also that NPIan in November has the second largest positive correlation of 0.700 with HFNan in June before 17 months. This relation may be one possible evidence indicating that the development of Aleutian Low pressure in winter is strongly affected by the sea surface heat flux over the North Pacific in early summer of the previous year.