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Long-Term Variability of the Western Edge of the North Pacific Subtropical High and Its Relation to Summer Temperatures over Japan, 1901-2000

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The long-term variability of the western edge of the North Pacific subtropical high (NPSH) and its relationship to summer temperature variability at 17 weather stations in Japan were investigated for the period from 1901 to 2000. Using the Hadley Center sea level pressure dataset (HadSLP2), we developed NPSH indices (NPSHIs) to describe both the zonal and meridional variability of the western edge of the NPSH. The NPSHIs revealed that the western edge of the NPSH had shifted southwestward over the past 100 years. This study contrasts the correlation of temperatures over Japan with NPSHIs between 1901-1950 (pre50) and 1951-2000 (post50). In the post50, a significant positive correlation between temperature and the meridional displacement of the western edge of the NPSH was observed at the most stations, which indicates that temperatures over Japan increase (decrease) when the western edge of the NPSH shifts northward (southward). In the pre50, in contrast, a significant positive correlation between temperature and the meridional displacement of the western edge of the NPSH was found at only two stations. In the post50, a strong relationship between the meridional displacement of the western edge of the NPSH and the east-west gradient of summertime sea surface temperature (SST) between the South China Sea and the tropical western Pacific east of the Philippines was observed, while there was no significant connection between them in the pre50. The Pacific-Japan (PJ) pattern, which affects meridional displacement of the western edge of the NPSH, is closely related to the east-west gradient of summertime SST across the Philippines. It is thus considered that the PJ pattern is excited frequently in the post50, which may affect the relationship between the meridional displacement of the western edge of the NPSH and summer temperatures over Japan.

Key words: North Pacific subtropical high, long-term variability, temperature, Pacific-Japan pattern, sea surface temperature

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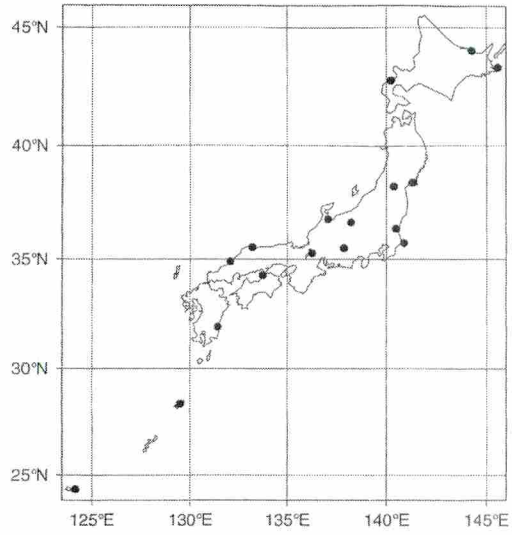

Fig. 1 Locations of 17 weather stations in Japan

Table 1 Correlation coefficients between the NPSHI and SST east-west difference for 1901–1950 (pre50) and 1951–2000 (post50)

	NPSHI-Z	NPSHI-M
pre50	−0.12	−0.03
post50	0.37**	0.36*

One and two asterisks indicate a significant correlation at the 5% and 1% level, respectively.

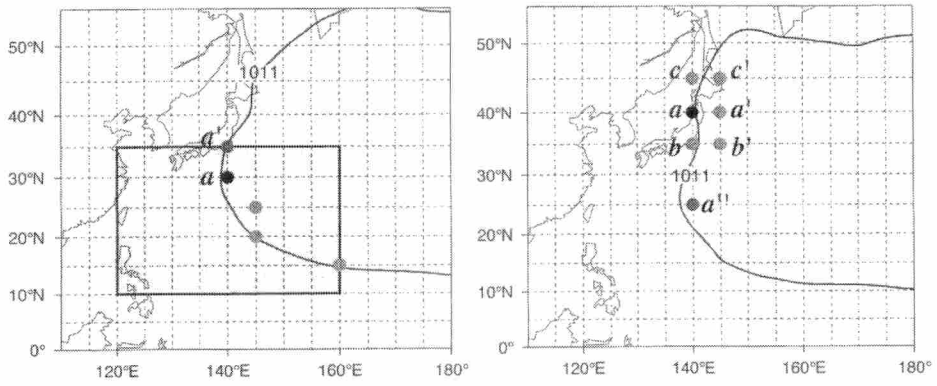

Fig. 2 Examples of the definition of the NPSHI

Left panel: July 1928. The circles indicate the grids that are 1,011 hPa or greater and 5 degrees to the west the grids are less than 1,011 hPa in the thick framed region. The westernmost grid point a is selected as the NPSHI ($a>a'$).

Right panel: August 1999. If the following cases are fitted, grid point a is defined as the NPSHI. 1) If b', a', and c' are 1,011 hPa or greater and higher than a'', which is fitted to the preceding NPSHI definition (see the left panel), 2) b, a, and c are less than 1,011 hPa, 3) $a>b$, $a>c$.

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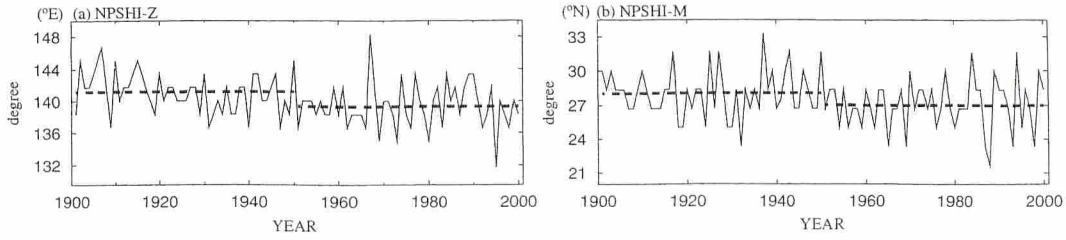

Fig. 3 Time series of summer (June, July, and August) averaged indices that describe (a) the zonal (NPSHI-Z) and (b) meridional (NPSHI-M) variability of the western edge of the NPSH
The heavy dotted lines in (a) and (b) denote the average index for 1901-1950 and 1951-2000.

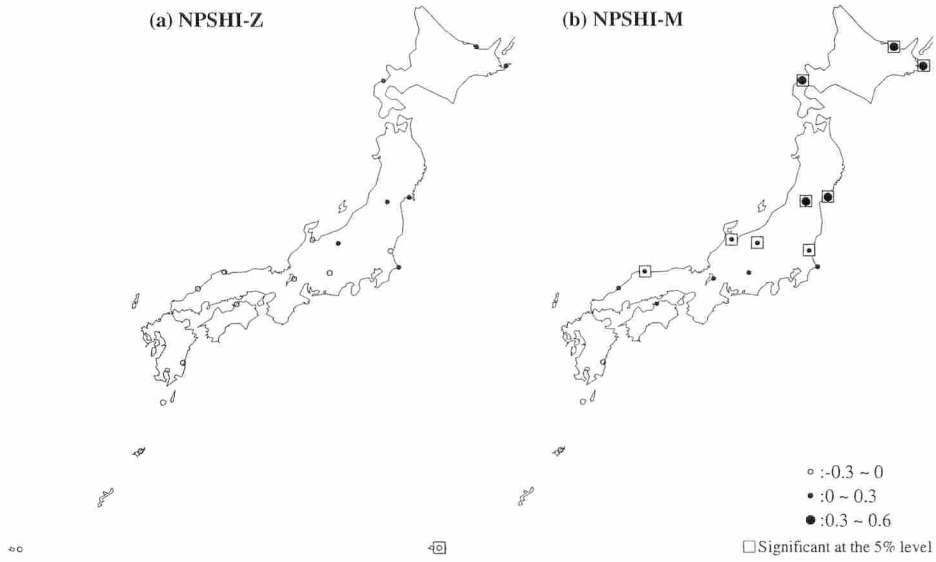

Fig. 4 Correlation coefficients between the NPSHI and summer temperature in Japan from 1901 to 2000
(a) NPSHI-Z, (b) NPSHI-M. Squares indicate stations with a significant correlation at the 5% level.

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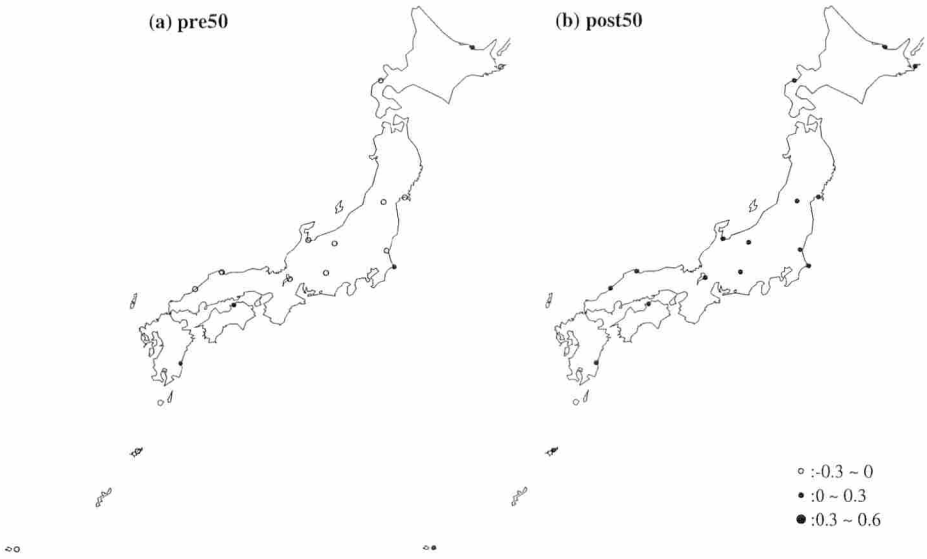

Fig. 5 Correlation coefficients between the NPSHI-Z and summer temperature in Japan (a) 1901-1950 (pre50), (b) 1951-2000 (post50).

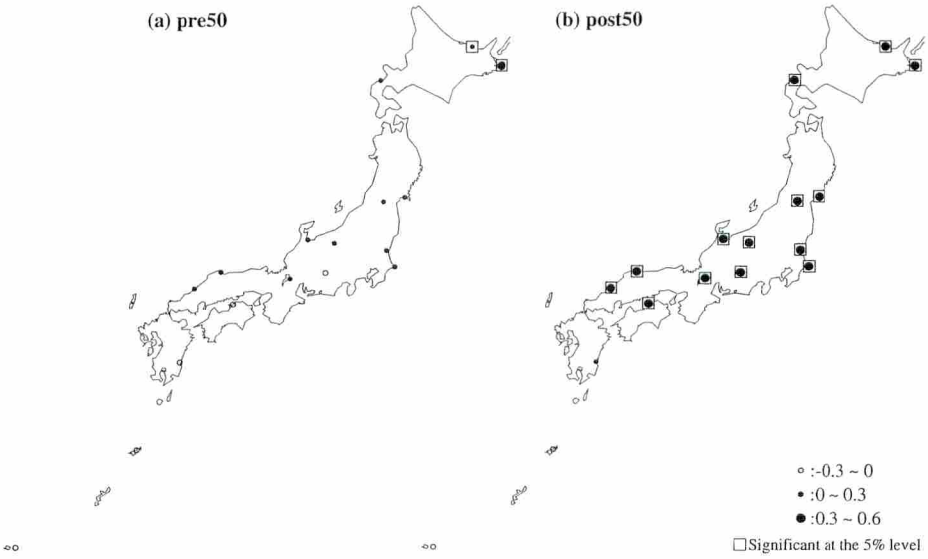

Fig. 6 Same as in Fig. 5 except that it shows the NPSHI-M Squares indicate stations with a significant correlation at the 5% level.

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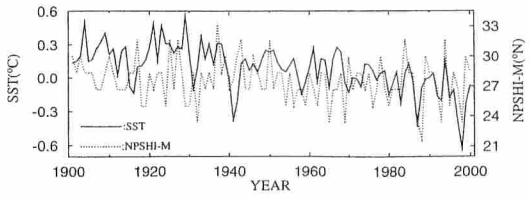

Fig. 7 Time series of the difference of the summer SST between regions C (5°–15°N, 110°–130°E) and D (5°–15°N, 140°–160°E; region D minus C), and NPSHI-M

The solid line indicates the SST, and the dotted line denotes the NPSHI-M.

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