Press Releases

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JAMSTEC
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Interdecadal Modulation of Summer Monsoon in Japanese Costal Waters ~The Pacific-Japan Pattern Correlates with Rice Yields and Typhoons~

A joint research team of Dr. Hisayuki Kubota, Department of Coupled Ocean-Atmosphere-Land Processes Research (DCOP) at the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) with Prof. Yu Kosaka, Research Center for Advanced Science and Technology at The University of Tokyo, and Prof. Shang-Ping Xie, Scripps Institution of Oceanography at University of California defined the Pacific-Japan (PJ) pattern[*1], a dominant pattern of interannual variability for the Western North Pacific (WNP) and East Asian summer monsoons, by digging out and examining atmospheric pressure data over 117 years from 1897 to 2013.

This long-term modulation revealed that the PJ index is correlated with climate variables including air temperature precipitation, Japanese rice yield, Yangtze River flow, and the occurrence of tropical cyclones in Taiwan and Okinawa region. Moreover, the PJ index demonstrated significant correlations with El Niño-Southern Oscillation (ENSO[*2]) in the preceding boreal winter and Indian Ocean temperature in summer. The relationship between PJ index and ENSO was modulated on interdecadal timescale, which influences correlation with climate variables in interdecadal timescale. These study results will contribute to seasonal forecast in Japan and East Asia summer, especially for climate factors such as typhoons, extreme hot and cool summer, which affect significantly people’s lives and agriculture

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This study was posted on the online journal of *International Journal of Climatology* by the Royal Meteorological Society, on July 30th (JST).
Title: A 117-year long index of the Pacific-Japan pattern with application to interdecadal variability
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*1 The Pacific-Japan (PJ) pattern: A north-south see-saw pattern of atmospheric pressure during summer over the western North Pacific. Professor Tsuyoshi Nitta found and named this pattern. In summers of the PJ pattern, Japan and East Asia are prone to extreme heat with less rainfall while summer monsoon is active in Southeast Asia, and the Philippine and South China Seas. In contrast, the negative PJ pattern results in cool summer with heavy rainfall in Japan and East Asia, and less rainfall in Southeast Asia, and the Philippine and South China Seas.

*2 El Niño-Southern Oscillation (ENSO): Every a few years, sea surface temperature along the equator in the eastern Pacific becomes anomalously high, a phenomenon called El Niño. The opposite situation (with anomalously cool temperature) is La Niña. These oceanic anomalies are intrinsically coupled to the overlying atmosphere, and this air-sea coupled variability is called ENSO. ENSO warm phase are El Niño and cool phase La Niña. Typically, it begins to develop in boreal summer and lasts for a year before start of the following summer, reaching its peak around December.

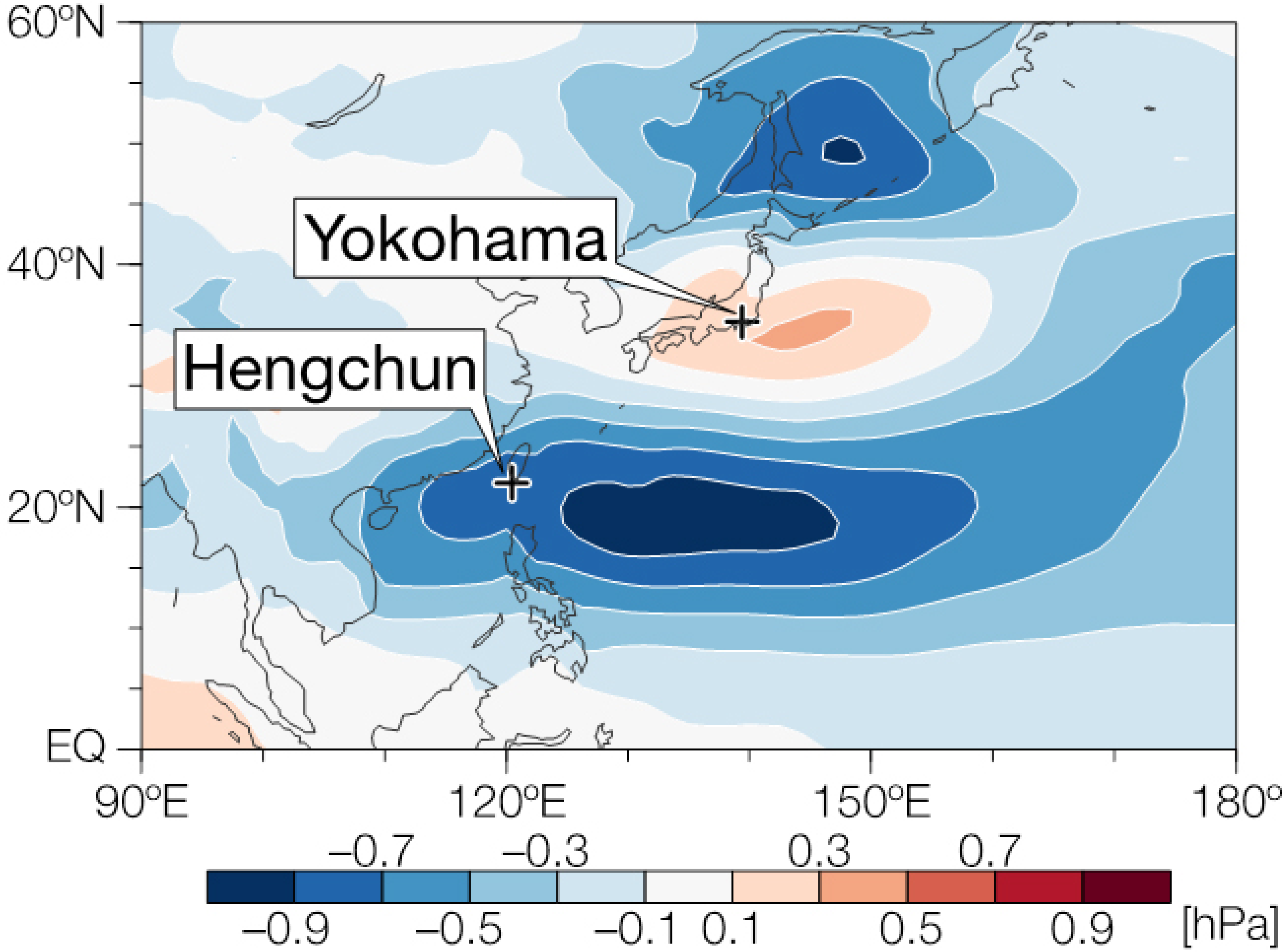

Figure 1: Structure of the PJ pattern based on interannual variability of atmospheric circulation and pressure distributions during summers (June-August) after 1979 when satellite observation was put in place. It shows regressed anomalies (deviations from normal years) of sea-level pressure associated with the typical positive PJ pattern. Here, sea level pressure is lower over the Philippine and South China Seas and higher over Japanese coastal waters than those of normal years. In this study, Yokohama was chosen for the positive pole in Japan and Hengchun for the negative pole in Taiwan to define the PJ pattern index as follows: The PJ index = P (Yokohama) − P (Hengchun)

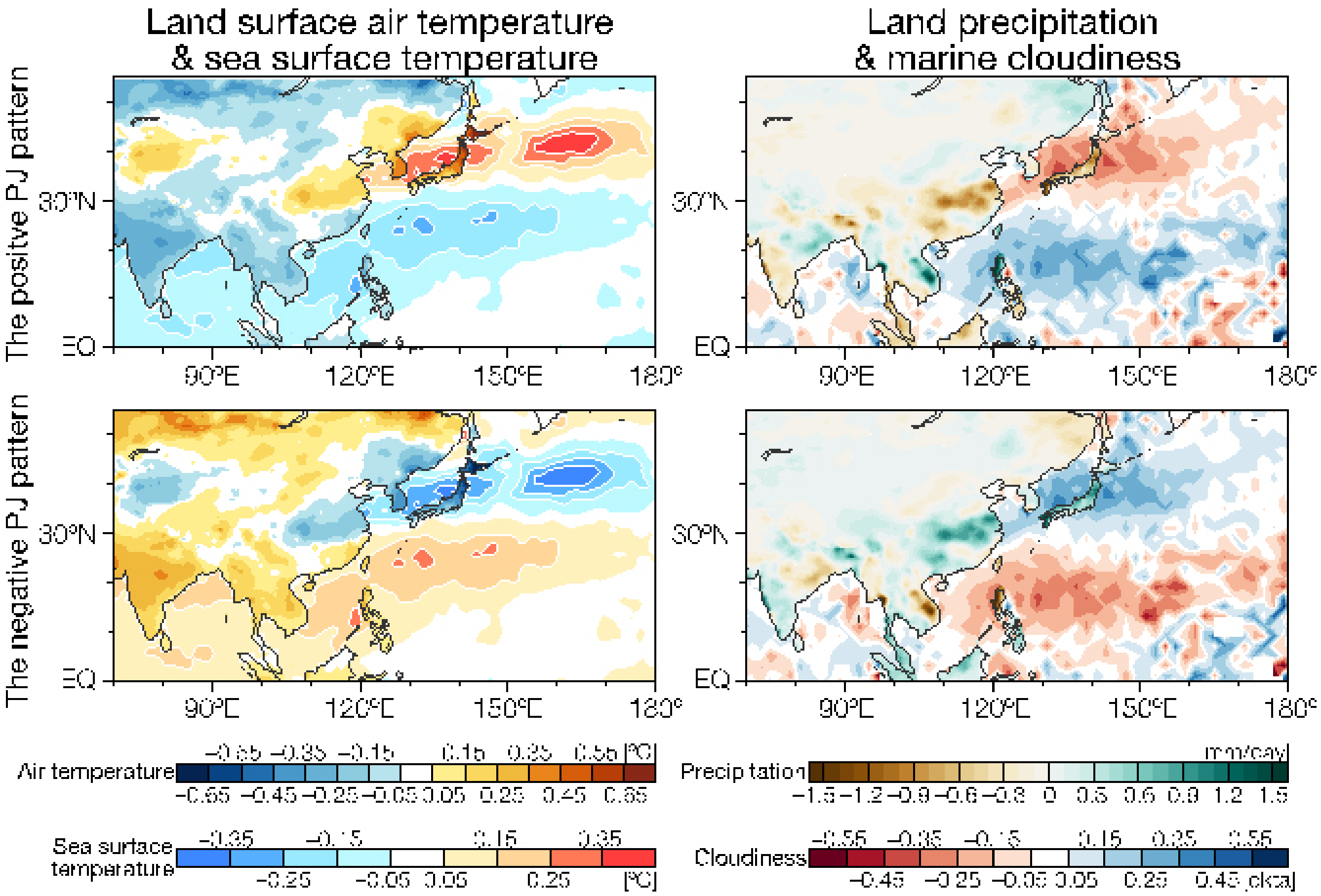

Figure 2: Anomalies (deviations from normal years) of land surface air temperature and sea surface temperature (left), and land precipitation and marine cloudiness (right) during summers (June-August) of the positive (top) and negative (bottom) PJ pattern from 1977 to 2012.
The positive PJ pattern shifts the prevailing WNP subtropical high northward, reaching Japan. Then, the land and sea surface temperatures become higher (top left), resulting in dry and sunny weather (top right) around Japan, while increased cloud activities over the Philippine and South China Seas bring heavy rainfall (top right). In contrast, the negative PJ pattern leads to cool and rainy summer in Japan and decreased rainfall around the Philippines.

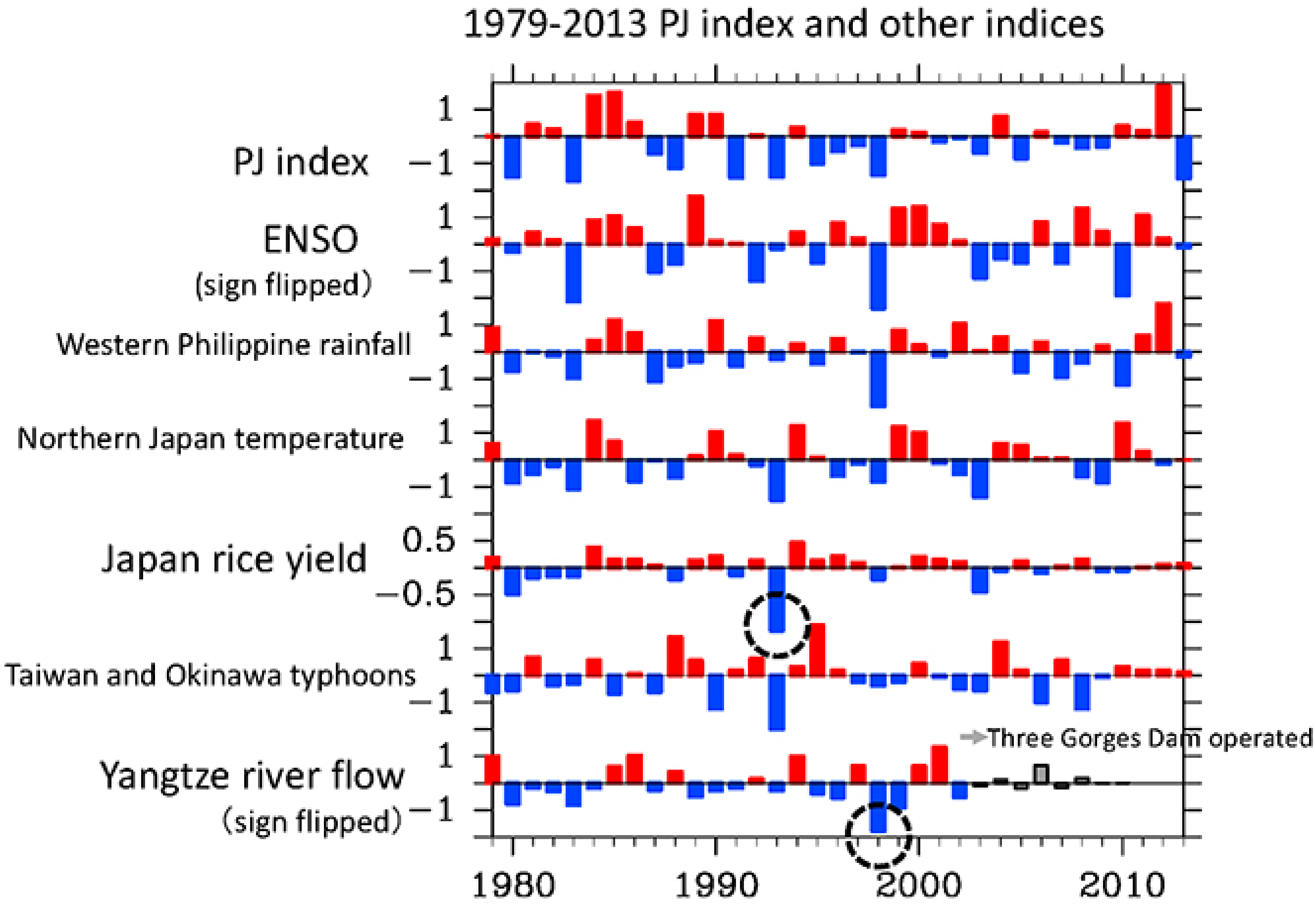

Figure 3: Time series of PJ Index, ENSO of the previous winter (the sign flipped), western Philippine summer (June–August) rainfall, Northern Japan summer temperature, Japan rice yields, the number of tropical cyclones in Taiwan and Okinawa regions, and Yangtze River flow (the sign flipped) during summer. When the PJ pattern is positive (red), Yangtze River water flow becomes less (dry), and Japan, Korea and Yangtze River basin tend to get very hot in summer. When the PJ pattern is negative (blue), however, the summer tends to be cool; e.g., poor rice harvest in Japan in 1993 and heavy flood in Yangtze River in 1998.

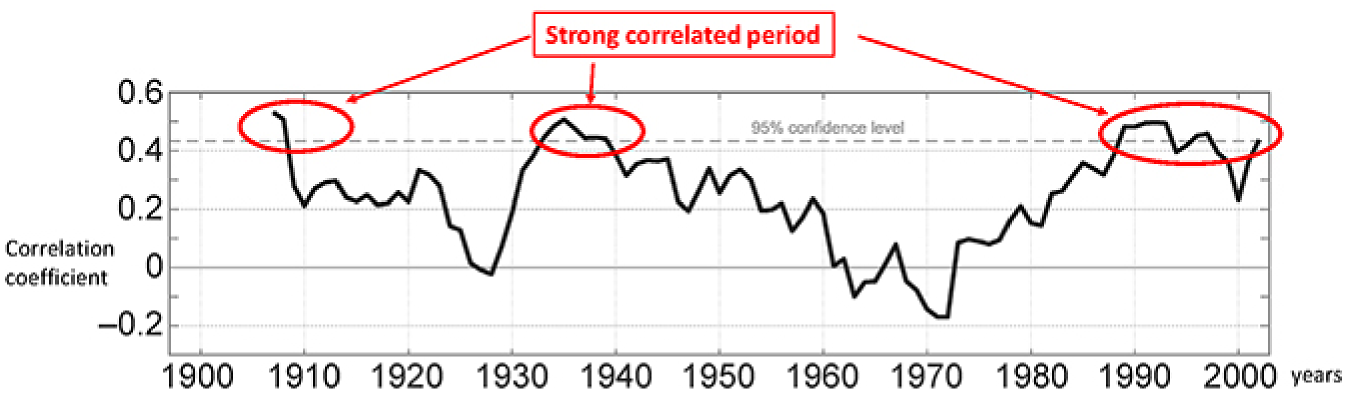

Figure 4: 21-year running correlations of the PJ pattern and ENSO indices. High magnitude above the dotted line represents strong correlation in statistical significance. Strong correlation appears in interdecadal timescale.

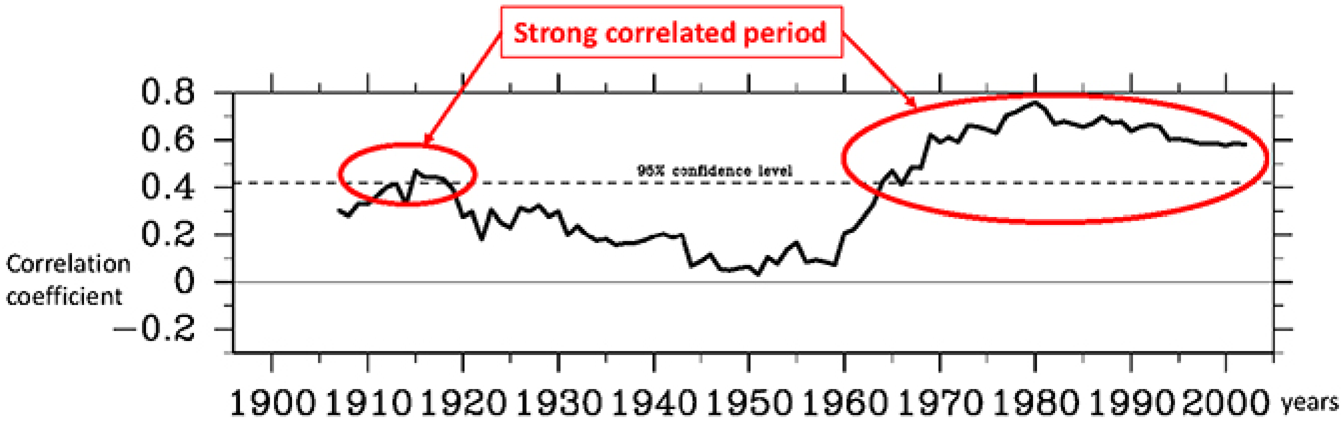

Figure 5: 21-year running correlation between rice yield per unit area in Japan and the PJ index. As shown in Fig. 4, strong correlation above the statistical significant level is also observed here in interdecadal timescale.

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