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A new centennial index to study the Western North Pacific Monsoon decadal variability

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The concept of the Western North Pacific Summer Monsoon (WNPSM) appeared for the first time in 1987. It is, unlike the Indian Summer Monsoon (ISM) and the East Asian summer monsoon (EASM), an oceanic monsoon mostly driven by the meridional gradient of sea surface temperature. Its circulation is characterized by a northwest-southeast oriented monsoon trough with intense precipitation and low-level southwesterlies and upper-tropospheric easterlies in the region [100º-130º E, 5º-15ºN].

Up to now, the primary index to characterize the WNPSM has been the Western North Pacific Monsoon Index (WNPMI) which covers the 1949-2013 period. The original WNPMI was defined as the difference of 850-hPa westerlies between two regions: D1 [5º–15ºN, 100º–130ºE] and D2 [20º–30ºN, 110º–140ºE]. Both domains are included in the main historical ship routes circumnavigating Asia for hundreds of years. Many of the logbooks of these ships have been preserved in historical archives and they usually contain daily observations of wind force and direction. Therefore, it has been possible to compute a new index of instrumental character, which reconstructs the WNPSM back to the middle of the 19th Century, by using solely historical wind direction records preserved in logbooks.

We define the monthly Western North Pacific Directional Index (WNPDI) as the sum of the persistence of the low-level westerly winds in D1 and easterly winds in D2. The advantages of this new index are its nature (instrumental) and its length (1849-2013), which is 100 years longer than the WNPMI (which was based on reanalysis data). Our WNPDI shows a high correlation ($r=+0.87$, $p<0.01$) with the previous WNPMI in summer for the 1949-2009 period, thus allowing to study the multidecadal variability of the WNPSM in a more robust way. Our results show that the WNPDI has a strong impact on the precipitation in densely populated areas in South-East Asia, such as the Philippines or the west coast of Myanmar where the changes in precipitation between well developed and weak monsoons can reach up to 400 mm. The relationships between the WNPDI and global climatic patterns such as the PDO, the ENSO or El Niño Modoki are extremely complicated and our results suggest that the influence of these patterns is highly non stationary.

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