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The West Pacific Gradient as novel index for ENSO system variability over the past Millennium

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Conflicting evidence points to either a strengthening or weakening Walker Circulation over the 20th century based on changes in SST and SLP gradients between the western and eastern Pacific (Coats & Karnauskas, 2017; L'Heureux et al., 2013). The difficulty to establish the correct sign of tropical Pacific SST gradient changes lies in the sparseness of data and differences between observational datasets which apply varying methods to correct observational biases, especially during the World War II period (Pfeiffer et al., 2017). Several ENSO reconstructions based on multi- or univariate proxy archives have provided invaluable insights into the past behavior of the ENSO system, yet do not fully agree on past El Niño or La Niña mean states (e.g. McGregor et al., 2010; Emile-Geay et al., 2013b). Since small changes in Pacific SST gradients connected with ENSO have global climate impacts, it is of paramount importance to develop robust indices of their past behavior.

New research has shown that during both El Niño and La Niña events the global impacts in terms of atmospheric circulation and precipitation were more severe when the SST anomalies in the westernmost Pacific (0-10°N, 130-150°E) were strongly opposing those in the central Pacific (5°S-5°N, 160-210°E). This temperature gradient is referred to as the West Pacific Gradient (WPG; Hoell and Funk, 2013; Zinke et al., 2015). A positive WPG is when WP SST anomalies are colder than those in the central Pacific, thus El-Niño-like conditions prevail.

This study aims to provide a reconstruction of the WPG and related tropical climate indices for the past Millennium to draw novel insights into past tropical climate variability. We make use of the PAGES2Kv.2 data archive (PAGES2K Consortium 2017) which contains a multivariate proxy data array to assess the interannual and decadal variability in the WPG and the Walker Circulation at annual resolution since 1600 AD and decadal means since 1000 AD. We will demonstrate that the WPG is a powerful index which tracks past ENSO, tropical Pacific SST and SLP gradients, the Walker Circulation and their associated climate teleconnections. Our results reveal distinct periods of persistent El Niño (1000-1050, 1100-1125, 1175-1185, 1250-1650) or La Niña-like (1125-1175, 1185-1250, 1650-200) conditions during the past Millennium associated with shifts in the strength of the Walker Circulation and Maritime Continent temperatures affecting global climate. The WPG serves as a novel index of past tropical climate variability and ENSO system variability aided by enhanced high-resolution proxy data coverage for the WPG region by far exceeding that for the Niño3.4 region.

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