Latitudinal shifts of the Southern Westerlies over the past millennium

*Kana Nagashima[1], Hitoshi Hasegawa[2], Nagayoshi Katsuta[3], Shinya Ochiai[4], Frank Lamy[5], Helge W. Arz[6], Takuto Kasuya[7], Masafumi MURAYAMA[8], Naomi Harada[1]

1. Japan Agency for Marine-Earth Science and Technology, Research Institute for Global Change, 2. Faculty of Science and Technology, Kochi University, 3. Faculty of Education, Gifu University, 4. Institute of Nature and Environmental Technology, Kanazawa University, 5. Alfred Wegener Institut für Polar- und Meeresforschung, 6. Leibniz Institute for Baltic Sea Research Warnemünde, 7. Department of Earth and Planetary Sciences, Kyushu University, 8. Faculty of Agriculture and Marine Science, Kochi University

Future change of the southern westerlies is critical because the position and intensity influence the precipitation pattern over South America and Australia and control upwelling at the frontal systems of the Antarctic Circumpolar Current. Recent model simulations showed a poleward shift of the southern westerlies in response to global warming (e.g., Simpson et al., 2014). However, instrumental observations are too short of examining a possible systematic poleward shift.
To examine the southern westerlies changes before and after the onset of global warming and to assess background variability, we reconstructed past southern westerlies changes during the last millennium using marine sediment cores (MR16-09 PL01 and PC01) obtained from the upper continental slope of southern Chile (46S, 76W, 1,535 m depth). The study site locates near the boundary of the present-day South Pacific summer and winter westerly jet path (e.g., Lamy et al., 2020); hence the site is regarded as very sensitive to the past southern westerlies shifts and accompanying latitudinal precipitation changes. First, we constructed precise age models for PL01 and PC01 cores over the last millennium based on eighteen ^{210}Pb measurements and additional ten ^{14}C dates. High-resolution (seasonal-scale) elemental composition using XRF core scanner (ITRAX) and lower-resolution mineral composition and grain size distribution show a increasing flux of lithogenic material since ca. AD1830, suggesting enhanced riverine input due to increased regional precipitation. Considering the modern latitudinal position of the westerlies and its spatial trends in precipitation, a poleward displacement of the winter westerlies is a plausible explanation for the observed precipitation change. Therefore, our results support the simulated poleward shift of the southern westerlies in response to global warming. Furthermore, we found the high frequency changes in the siliciclastic input characteristic for solar variability (ca. 10, 20, and 100 years). We therefore suggest that solar variability is an additional factor determining the southern westerlies' behavior at decadal to centennial-timescales.

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