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Tropical Pacific variability and anthropogenic forcing are the key drivers of the West Antarctic atmospheric circulation variability over the 20th century

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The future evolution of the West Antarctic Ice Sheet (WAIS) will strongly influence the global sea-level rise in the coming decades. Ice shelf melting in that sector is partly controlled by the low-pressure system located off the West Antarctic coast, namely the Amundsen Sea Low (ASL). When the ASL is deep, an overall increase in ice shelf melting is noticed. Because of the sparse observational network and the strong internal variability, our understanding of the long-term climate changes in the atmospheric circulation is limited, and therefore its impact on ice melting as well. Among all the processes involved in the West Antarctic climate variability, an increasing number of studies have pointed out the strong impact of the climate in the tropical Pacific. However, most of those studies focus on the past decades, which prevents the analysis of the role of the multi-decadal tropical variability on the West Antarctic climate. Here, we combine annually-resolved paleoclimate records, in particular ice core and coral records, and the physics of climate models through paleoclimate data assimilation to provide a complete spatial multi-field reconstruction of climate variability in the tropics and Antarctic. This allows for studying both the year-to-year and multi-decadal variability of the tropical-Antarctic teleconnections. As data assimilation provides a climate reconstruction that is dynamically constrained, the contribution of the tropical variability on the West Antarctic climate changes can be directly assessed. Our results indicate that climate variability in the tropical Pacific is the main driver of ASL variability at the multi-decadal time scale, with a strong link to the Interdecadal Pacific Oscillation (IPO). However, the deepening of the Amundsen Sea Low over the 20th century cannot be explained by tropical climate variability. By using large ensembles of climate model simulations, our analysis suggests anthropogenic forcing as the primary driver of this 20th century ASL deepening. In summary, the 20th century ASL deepening is explained by the forcing, but the multi-decadal variability related to the IPO is superimposed on this long-term trend.