Extreme precipitation events in firn core isotopic records: where to find the best drilling site?

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Extreme precipitation events (EPE), defined as the top 10% of daily precipitation amounts, play a major role in Antarctica surface mass balance as they account for more than 40% of the total annual precipitation across the continent. These EPEs are often associated with high temperatures and have major consequences on the Antarctic surface mass balance. Though, it is key to estimate their recent evolution in terms of frequency and intensity in the context of climate change. As water stable isotopic composition of firn cores is known to record the temperature signal modulated by precipitation intermittency, and to be imprinted as well as by the large-scale atmospheric circulation, we can ask if EPEs could be detected in firn cores thanks to a particular isotopic signature.

In this study we construct Virtual Firn Cores (VFC) across Antarctica to investigate how winter EPEs can be misinterpreted as summer maxima in firn cores. We create VFC using (1) temperature, precipitation rate and a linear temperature-d\textsubscript{18}O relationship from atmospheric regional model MAR, (2) d\textsubscript{18}O in precipitation from ECHAM6-wiso and (3) d\textsubscript{18}O in precipitation from LMDZ6-iso, for the period 1979-2022. Additionally to standard VFCs, we generate a second set of VFCs excluding each year the highest winter precipitation event (5-days period). We then run a detection algorithm to find local maxima for both sets of VFCs. We observe some regions with nearly 20% more “summer” detected in standard VFCs compared to VFCs without the winter maximum precipitation event. We argue that firn cores drilled in those regions are more likely to contain isotopic signals that could be used to detect EPEs temporal variability.