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Reconstruction of the meridional shifts of the South Westerly Winds during the last glacial cycle and effect on atmospheric CO_2 content

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Position and strength of the South Westerly Winds (SWW) play a major role in Earth's climate, as they control both the Southern Ocean vertical stratification and dust inputs to the area. The latter is the primary source of iron - a limiting micronutrient - to the Southern Ocean. Hence, dust inputs regulate the biological carbon pump. The observed variations in atmospheric CO_2 both at the Glacial/Interglacial and millennial time scales could be linked to changes in primary productivity and ocean stratification in the Southern Ocean, as the result of SWW modifications. However, meridional and intensity shifts of the SWW during the Quaternary remain largely debated.
Radiogenic isotopes of Pb, Nd and Sr are powerful tools to reconstruct source-to-sink transport and origin of continental material. I will show how we used these isotopes to trace dust provenance to the Atlantic Southern Ocean using deep-sea sediment cores and reconstruct the changes in wind pattern. Changes in dust provenance are synchronous with cold and warm periods at the Glacial/Interglacial time-scale over the last 160 ka. We also observe changes in dust sources during abrupt climatic events, such as the warm Antarctic Isotopic Maximum, over the last 40 ka. We have defined potential dust source areas based on both literature data and new measurements on moraines and river sediments. Patagonia is the major dust source, contributing more during the main dust peaks. The high-altitude Puna Plateau appears as the other important dust source to the Atlantic Southern Ocean. We interpret the provenance changes in terms of a northward shift of the SWW during cold periods, deflating more erodable material from the Patagonian plains east of the Andes. During abrupt warm events, the source change can be interpreted as a displacement of the core of the SWW to the south compared to the Holocene. This resulted in an enhanced deep Southern Ocean ventilation and a decrease of the biological pump efficiency that could explain the higher atmospheric CO_2 concentrations observed during Antarctic Isotopic Maximum events.