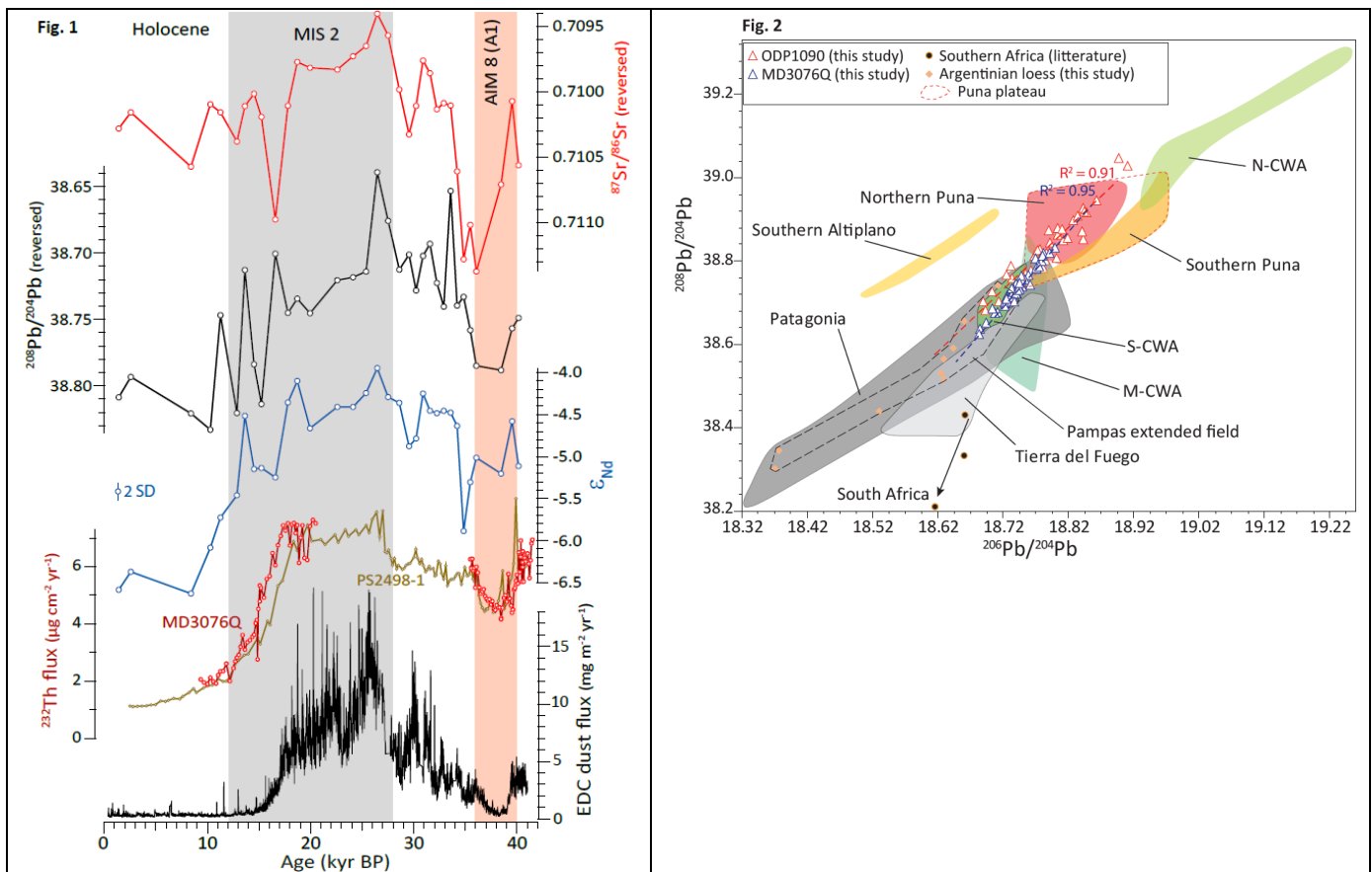


FINAL REPORT PROGRAM LEFE

Program LEFE / IMAGO	Project Title	Years 2019 – 2021
	DUST: MeriDional shifts of the SoUth WeSTerly winds and their impact on the biological pump in the Atlantic Southern Ocean	
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<p>Context: The meridional shift of the South Westerly winds can influence the atmospheric p_{CO_2} via two main mechanisms: biological pump activity and vertical ocean stratification. However, the timing, the amplitude and direction of the shifts remain debated as both modeling studies and data-based reconstructions disagree.</p> <p>Objectives / scientific questions: The objectives of DUST were to reconstruct temporal variations in dust provenance to the Southern Atlantic Ocean notably using radiogenic isotopes (Pb, Sr, Nd) to study the evolution of atmospheric circulations over the area. The time scales considered were first Glacial/Interglacial (core ODP1090), then focusing on the abrupt Antarctic Isotope Maximum (AIM) events (cores MD07-3076Q and 3077).</p> <p>Main results: Pb, Nd and Sr isotopic ratios show high amplitude variations over the last two Glacial/Interglacial cycles in ODP1090. Similar variations are recorded in core MD3076Q during the last deglaciation (Fig. 1). Furthermore, in core MD3076Q, the radiogenic isotopes ratios show marked variations around AIM 8, although with lower amplitudes (Fig. 1). These latter variations also correspond to a decrease in the dust flux as shown by the ^{230}Th-normalized ^{232}Th measured in the same core and a nearby core (PS2498-1). A similar dust flux reduction is also observed in Antarctica.</p> <p>We were able to show that the Glacial/Interglacial variations correspond to changes in the relative contributions of two dust sources located in South America (Fig. 2): Patagonia - a well-known dust source - and the high-altitude Puna Plateau. The relative contribution of Patagonia prominently increases during periods of higher dust flux over the South Atlantic Ocean and Antarctica. We interpret the changes in relative dust contributions as reflecting a northward shift of the core of the South Westerly winds during Glacial periods, in particular during the Last Glacial Maximum. This results in an increase 1) of dust deposition north of the polar front that would enhance the biological pump activity and 2) of the vertical stratification of the Southern Ocean south of the polar front that would limit ocean CO_2 outgassing to the atmosphere.</p> <p>For AIM 8, the preliminary results show that a third dust source, characterized by higher Sr isotope ratios values, became a major contributor during this abrupt event. Although in need of further analyses, it appears that the high-altitude plateau of the central western Argentina could be this dust source. At the same time, the relative contributions of the Puna Plateau and/or Patagonia decreased.</p>		
<p><u>Next page</u></p> <p>Fig. 1 (left, unpublished). Temporal evolution of three radiogenic isotopic ratios (Sr, Pb, Nd) in core MD3076Q over the last 45 ka. The ^{230}Th-normalized ^{232}Th - a proxy for dust flux - in cores MD3076Q and PS2498-1 and the dust flux recorded in Antarctica (EPICA Dome C (EDC) ice core) are also shown. The grey area underline AIM 8 (A1).</p> <p>Fig. 2 (right, unpublished). $^{208}Pb/^{204}Pb$ vs. $^{206}Pb/^{208}Pb$ plot of core ODP1090 with the potential dust sources areas (PSA) in South America. The ODP1090 data form a linear correlation that we interpret as representing a binary mixing between two PSA. The ϵ_{Nd} and $^{87}Sr/^{86}Sr$ data (not shown) further suggest that most of the dust reaching ODP1090 is coming from Patagonia and the Puna Plateau.</p>		



Future of the project: the project has been largely impacted both by the repeated sick leaves of the PhD student⁽²⁾ who was at the center of the project and by covid-19. The work-package on compound-specific δD and $\delta^{13}C$ still needs to be fully conducted. A master student and a technician will complete this WP within the next 12 months (financial support AG Martinez-Garcia, MPIC). The high time resolution dust provenance during AIM has only been completed to *ca.* 40% of the initial target. A master student from Lyon will be hosted at MPIC (June-July 2023) to complete the study under SP supervision (financial support G. Haug, MPIC). Based on the existing results from the DUST project and pilot study, a paper on model-data comparison for dust flux variations during Heinrich Stadial 1 has been published in *Geophys. Res. Lett.*¹. A paper on dust provenance to the Southern Atlantic Ocean and the meridional shift of the South Westerlies at the Glacial/Interglacial time-scale will be submitted in April 2023. Two further manuscripts are planned: i) Abrupt meridional shifts of the South Westerlies during AIMs and effect on p_{CO_2} , and ii) Argentinian loess provenance over the last glacial cycle.

Nombre de publications, de communications et de thèses (updated 08 April 2023)

The names of supervised persons within the project are underlined, * presenting author

Research Article

¹ Hopcroft, P., Pichat S., Valdes P.J., Kienast S.S. (2022) Sensitivity of the tropical dust cycle to Glacial abrupt climate changes. *Geophys. Res. Lett.* **49**, e2022GL101197 [doi: 10.1029/2022GL101197](https://doi.org/10.1029/2022GL101197)

Communications:

Pichat*, Lodyga, Darragon, Gravier, Gottschalk, Vásquez-Riveiros, Waelbroeck, Zárata, Haug, Galer (2022) DUST : Meridional shifts of the South Westerly winds and their impact on the biological pump in the Atlantic Southern Ocean. Talk. *Colloque national LEFE-IMAGO*, Gif-sur-Yvette, France, 21-22 Nov.

Pichat*, Gravier, Darragon, Lodyga, Schmidt, Gottschalk, Fletcher, Benkkadour, Mischke, Vásquez-Riveiros, Waelbroeck, Haug, Galer, Zielhofer (2022) Reconstructing paleo wind circulations using dust provenance: ocean and lake case studies. Poster. *Colloque national LEFE-IMAGO*, Gif-sur-Yvette, France, 21-22 Nov.

Lodyga, Gravier, Schaaff, Galer, Gottschalk, Haug, Pichat* (2021) Meridional shifts of the South Westerly Winds over the Southern Atlantic Ocean over the last 40 ka. Talk. *Réunion des Sciences de la Terre*, Lyon, France, 01-05 Nov.

Pichat*, Gravier, Schaaff, Lodyga (2021) Meridional shifts of the South Westerly Winds over the Southern Atlantic Ocean during abrupt climate events. Talk. *Goldschmidt 2021*, 04-09 July

Encadrements:

- Ophélie Lodyga (2018, thèse², supervision: S. Pichat)
- Aurore Darragon (2021, Master (M1) research internship, 11 weeks) Study of potential dust sources in the Southern Atlantic during AIM of the last 60 ka (supervision: S. Pichat)
- Valentine Schaaf (2019, Master (M1) research internship, 10 weeks) Tracing dust sources to the South Atlantic during the last 40,000 years using Pb, Sr and Nd isotopes: pilot study on core MD07-3076Q (supervision: S. Pichat)

² Note: the PhD thesis started 01-Sep-2018 “Effect of the position and intensity of the South Westerlies on dust fertilization and stratification of the Southern Atlantic Ocean” at the center of this project has been stopped (May 2022) due to long-term sick leaves. From Sept. 2018 to May 2022, the PhD student has been working 4.5 months full time and 3.5 month 50% time

