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Story-telling the last glacial inception: CO₂, AMOC weakening and orbital triggers

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The transition from glacial to interglacial periods has been deeply studied, largely relying on the last deglaciation and its associated availability of a vast array of precisely dated high-resolution climate indicators. Its counterpart transition, glacial inception, has received much less attention, mostly due to the lack of a sufficient number of well-resolved proxies covering the last glacial inception at the end of the last interglacial (129–116 ka). As a consequence, there are significant knowledge gaps concerning overall driving mechanisms, lead/lag relationships and the role of each orbital parameter. Specifically, a long-standing issue has been why does CO₂ lag Antarctic Temperature by five thousand years during glacial inception, in sharp contrast to an otherwise strong correlation throughout the 800 ka record.

Here, using a dry-extraction technique, we present a reconstruction of past atmospheric CO₂ concentrations from the EDC ice core for the period 135–105 ka at centennial resolution. Focusing on the glacial inception, we suggest that the CO₂ drawdown at the end of the last interglacial was triggered by a weakening of the Atlantic Meridional Overturning Circulation (AMOC). After cascading events in the Northern Hemisphere that led to an unusually mild climate amidst growing ice sheets, a sudden reduction in North Atlantic Deep Water formation possibly triggered the establishment of a glacial AMOC. The northward expansion of Antarctic Bottom Water that likely followed may have helped create the necessary conditions for enhanced deep ocean storage of CO₂. A coeval quick expansion of the Northern ice sheets and associated positive feedback mechanisms possibly helped to sustain the CO₂ decrease. We suggest that the establishment of a deep ocean reservoir was a necessary condition for CO₂ to drop from the long and stable plateau that we observe during the last interglacial, ultimately explaining the lag between CO₂ and Antarctic temperature.

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