EGU25-5934, updated on 13 May 2025
https://doi.org/10.5194/egusphere-egu25-5934
EGU General Assembly 2025

Closing the Plio-Pleistocene ^{13}C cycle in the 405-kyr periodicity by isotopic signatures of geological sources

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To unravel which processes are responsible for changes in atmospheric CO_2 the carbon isotopes are useful helpers widely applied in the past. This study helps to better understand long-term changes in ^{13}C, which has also consequences for the interpretation of atmospheric $\delta^{13}CO_2$ measured together with CO_2 in ice cores.

The ^{13}C cycle of the Plio-Pleistocene, as recorded in $\delta^{13}C$ of benthic foraminifera, has power in periodicities related to the long eccentricity cycle of 405-kyr that is missing in corresponding climate records (e.g. $\delta^{18}O$). Using a global carbon cycle model I show that the long eccentricity cycle in $\delta^{13}C$ might have been caused by variations in the isotopic signature of geological sources, namely of the weathered carbonate rock ($\delta^{13}C_{rock}$) or of volcanically released CO_2 ($\delta^{13}C_v$). This closure of the ^{13}C cycle in these peridicities also explains the offset in atmospheric $\delta^{13}CO_2$ seen between the penultimate and the last glacial maximum. The necessary isotopic signatures in $\delta^{13}C_{rock}$ or $\delta^{13}C_v$ which align my simulations with reconstructions of the ^{13}C cycle on orbital timscales have most power in the obliquity band (41-kyr) suggesting that land ice dynamics are the ultimate cause for these suggested variations. Since the Asian monsoon as reconstructed from speleothems has also an obliquity-related component it is possible that these proposed changes in weathering are indeed, at least partly, connected to the monsoon as previously suggested. Alternatively, the suggested impact of land ice or sea level on volcanic activity might also be influential for the ^{13}C cycle. This indirect influence of ice sheets on the long eccentricity cycle in $\delta^{13}C$ implies that these processes might not have been responsible for the 405-kyr periodicity found in ice-free times of the pre-Pliocene parts of the Cenozoic.

See preprint (https://doi.org/10.5194/cp-2024-63) for details.