

EGU26-5914, updated on 26 Aug 2026

<https://doi.org/10.5194/egusphere-egu26-5914>

EGU General Assembly 2026

© Author(s) 2026. This work is distributed under the Creative Commons Attribution 4.0 License.



Input and output fluxes of surface CO₂ throughout the Cenozoic

Luca Castrogiovanni¹, Claudia Pasquero¹, Nicola Piana Agostinetti¹, Bram Vaes^{1,2}, Jack Longman³, and Pietro Sternai^{1,4}

¹Department of Earth and Environmental Sciences, University of Milano-Bicocca, Milan, Italy

²Aix-Marseille Université, CNRS, IRD, INRAE, CEREGE, Europôle Méditerranéen de l'Arbois, Aix-en-Provence Cedex, France

³Department of Geography and Environmental Sciences Department, Northumbria University, UK

⁴GFZ German Research Centre for Geosciences, Potsdam, Germany

Changes in the geological carbon cycle and associated surface input and output CO₂ fluxes drive long-term Cenozoic climate trends mainly through magmatic emissions and weathering of silicate minerals. Proxy records, which indirectly reconstruct past climate conditions, demonstrate a steady decline in both surface CO₂ and temperature since ~50 million years ago (Ma), punctuated by shorter periods of climatic optima and hyperthermals such as the PETM, EECO, MECO and MMCO. However, lack of constraints in terms of input and output CO₂ fluxes prevents the assessment of responsible processes for these trends. Here, we use a newly developed technique based on a reversible-jump Markov chain Monte Carlo algorithm (rj-McMC) to invert the temporal CO₂ changes from the Proxy Integration Project (CENCO₂PIP) (Hönisch et al., 2023) and obtain estimates of the surface input and output CO₂ fluxes throughout the Cenozoic. We base the inversion on a general formulation of the geological carbon cycle that includes a degassing source and a temperature-dependent sink term, with the temperature time history (Hansen et al., 2023) used as an additional constraint. Reconstructed fluxes reveal that perturbations of the carbon cycle are stronger during the early Cenozoic (i.e., ~66 – 34 Ma), while these reduce since ~34 Ma. We hypothesise that stronger degassing from the solid-Earth during the EECO and MECO prevent an earlier onset of the Antarctic ice cap during the Eocene. We discuss that the higher carbon emissions during these periods can partially link to the evolution of the Neo-Tethyan magmatic margin, which extinction occurs ~34 Ma. Results show that carbon flux stabilization since the Oligocene could be due to temperature dependent processes like albedo increase and enhanced silicate weathering in the context of Tibetan Plateau uplift. Finally, we estimate that the net amount of CO₂ removed since ~34 Ma is four times greater than that of the first half of the Cenozoic.

References

Hansen, J. E., Sato, M., Simons, L., Nazarenko, L. S., Sangha, I., Kharecha, P., Zachos, J. C., von Schuckmann, K., Loeb, N. G., Osman, M. B., Jin, Q., Tselioudis, G., Jeong, E., Lacis, A., Ruedy, R., Russell, G., Cao, J., & Li, J. (2023). Global warming in the pipeline. *Oxford Open Climate Change*, 3(1). <https://doi.org/10.1093/oxfclm/kgad008>.

Hönisch, B., Royer, D. L., Breecker, D. O., Polissar, P. J., Bowen, G. J., Henahan, M. J., Cui, Y., Steinthorsdottir, M., McElwain, J. C., Kohn, M. J., Pearson, A., Phelps, S. R., Uno, K. T., Ridgwell, A., Anagnostou, E., Austermann, J., Badger, M. P. S., Barclay, R. S., Bijl, P. K., ... Zhang, L. (2023). Toward a Cenozoic history of atmospheric CO₂. *Science*, 382(6675). DOI: 10.1126/science.adi517.