EGU24-11285, updated on 09 Dec 2024
https://doi.org/10.5194/egusphere-egu24-11285
EGU General Assembly 2024

Global expression of bomb radiocarbon in Earth's surface carbon reservoirs

Timothy Eglinton[1] and the Bomb-spike team[*]
[1]Geological Institute, Department of Earth Sciences, ETH Zurich, 8092 Zurich, Switzerland (timothy.eglinton@erdw.ethz.ch)
[*]A full list of authors appears at the end of the abstract

The Earth's carbon cycle encompasses myriad processes that connect different reservoirs containing diverse forms of carbon that turnover and exchange on a wide range of spatial and temporal scales. Increased atmospheric CO_2 from anthropogenic perturbation of the carbon cycle associated with fossil fuel combustion and land-use change reflects the release of carbon from stable, slow-cycling reservoirs. Much current research seeks to quantify carbon transfer from slow to fast cycling reservoirs, as well as the ability of different carbon reservoirs, particularly the terrestrial biosphere and the oceans, to compensate for these increased CO_2 emissions through carbon uptake and storage. Determination of the turnover time and rate of transfer of carbon between reservoirs is crucial in this regard. Radiocarbon, ^{14}C, represents a powerful tool to address this question by virtue of its ~ 5700-year half-life that allows processes occurring on centennial to millennial timescales to be resolved. Superimposed on natural abundance ^{14}C variations, above-ground nuclear weapons testing during the mid-20th Century created an abrupt spike in atmospheric radiocarbon ("bomb spike") that has subsequently permeated into and moved through various Earth surface carbon reservoirs, serving as a useful tracer of carbon cycle processes occurring on annual to decadal timescales. Numerous studies have exploited this signal for assessment of turnover or transit times within and through carbon pools, atmospheric and oceanic circulation, ecosystem functioning and source attribution. However, much ^{14}C data currently tends to be compartmentalized, with a focus on specific reservoirs or geographic locations.

In this study, we evaluate the global expression of the radiocarbon bomb spike across the different Earth surface active carbon reservoirs (terrestrial biosphere, soils, freshwater aquatic systems, and marine carbon reservoirs). We compile ^{14}C data from existing and nascent databases as well as new measurements, including direct observations and records from natural archives spanning the pre-bomb period to the present, to develop an overview of the general features of ^{14}C (timing, amplitude and character of the bomb peak) within each reservoir over this time interval. In addition to using this information to refine our understanding of the interactions between different reservoirs, this study seeks to (i) identify gaps and biases in data with a view to motivating further ^{14}C studies, (ii) underline the value of systematic data reporting, as well as careful archiving of samples for future ^{14}C analysis, (iii) inform isotope-enabled carbon cycle and earth system models, and (iv) serve as benchmark against which to gauge future carbon cycle

changes.

Bomb-spike team: Eglinton T.I. (1), Blattmann T. (1), Bolandini M. (1), Broeder L. (1), Bruni E. (1), Brunmayr A. (2), Coppola A. (1), Duborgel M. (1,3), Geissbuehler D. (4), Gies H. (1), Graven H. (2), Hagedorn F. (3), Haghipour N. (1,5), Heusser C. (1,5), Laemmel T. (4), Minich L. (1,3), Mittelbach B. (1), Nakajima K. (1,5), Paradis S. (1), Rhyner T. (1), Schnepper C. (1), Szidat S. (4), Wacker L. (5), Wartenweiler S. (1), Welte C. (1,5), Wertnik M. (1,5), White M. (1)