Using the radiocarbon bomb spike to identify the age of soil organic carbon deposited in Lake Constance sediments.

ETH zürich · eawag aquatic research

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1 **Sedimentary bulk O^{14}C records the atmospheric bomb spike.**

2 **Aquatic DI^{14}C rapidly incorporates bomb ^{14}C while soil OC has a transit time of 161 ± 19 years.**

3 **Flood deposits have a relatively higher content of fossil, rock-derived OC.**

Abstract

Sharing is encouraged

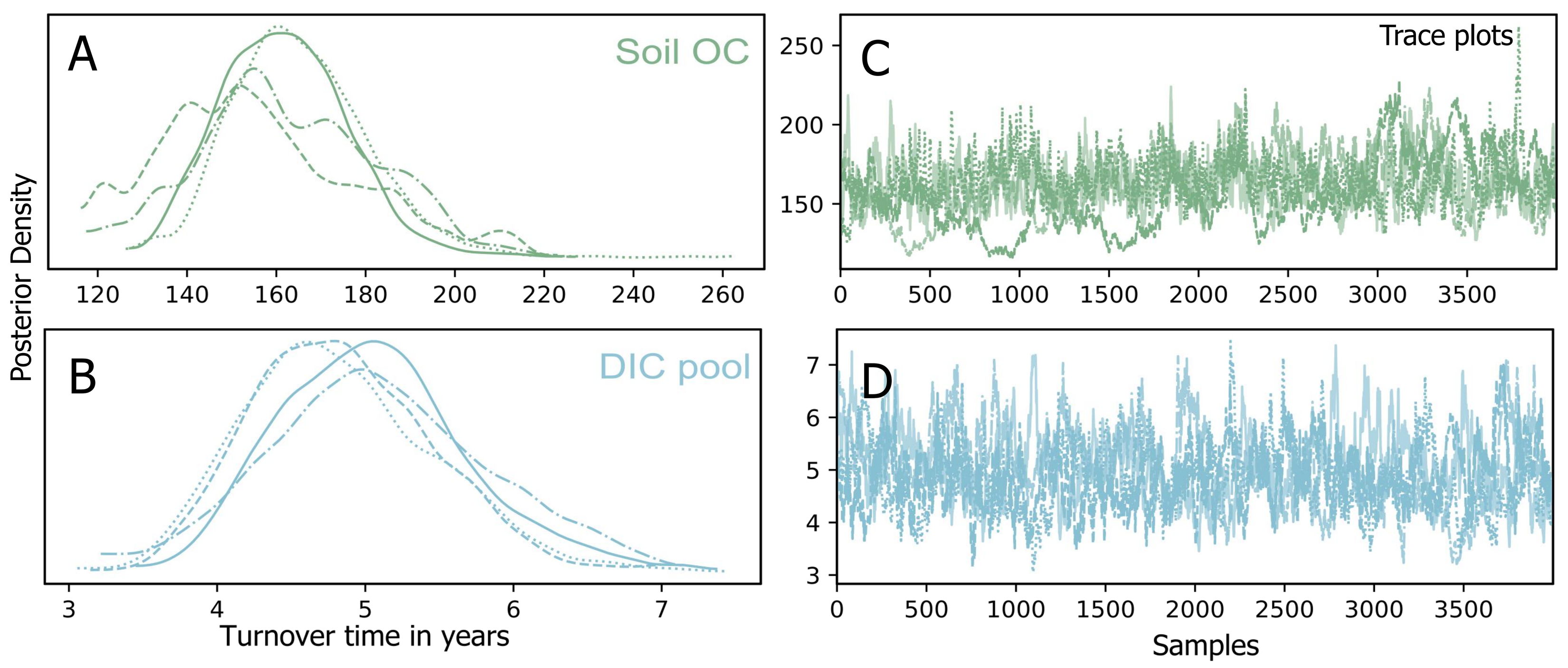
Relevance

The residence time of organic carbon (OC) in terrestrial ecosystems is crucial to assess its reaction to climate and land use change. Lake sediments integrate OC from their catchment, acting as both burial sites of OC and archives of catchment processes. Sedimentary OC sources include aquatic primary productivity, soil OC , and rock-derived OC.

Modeling

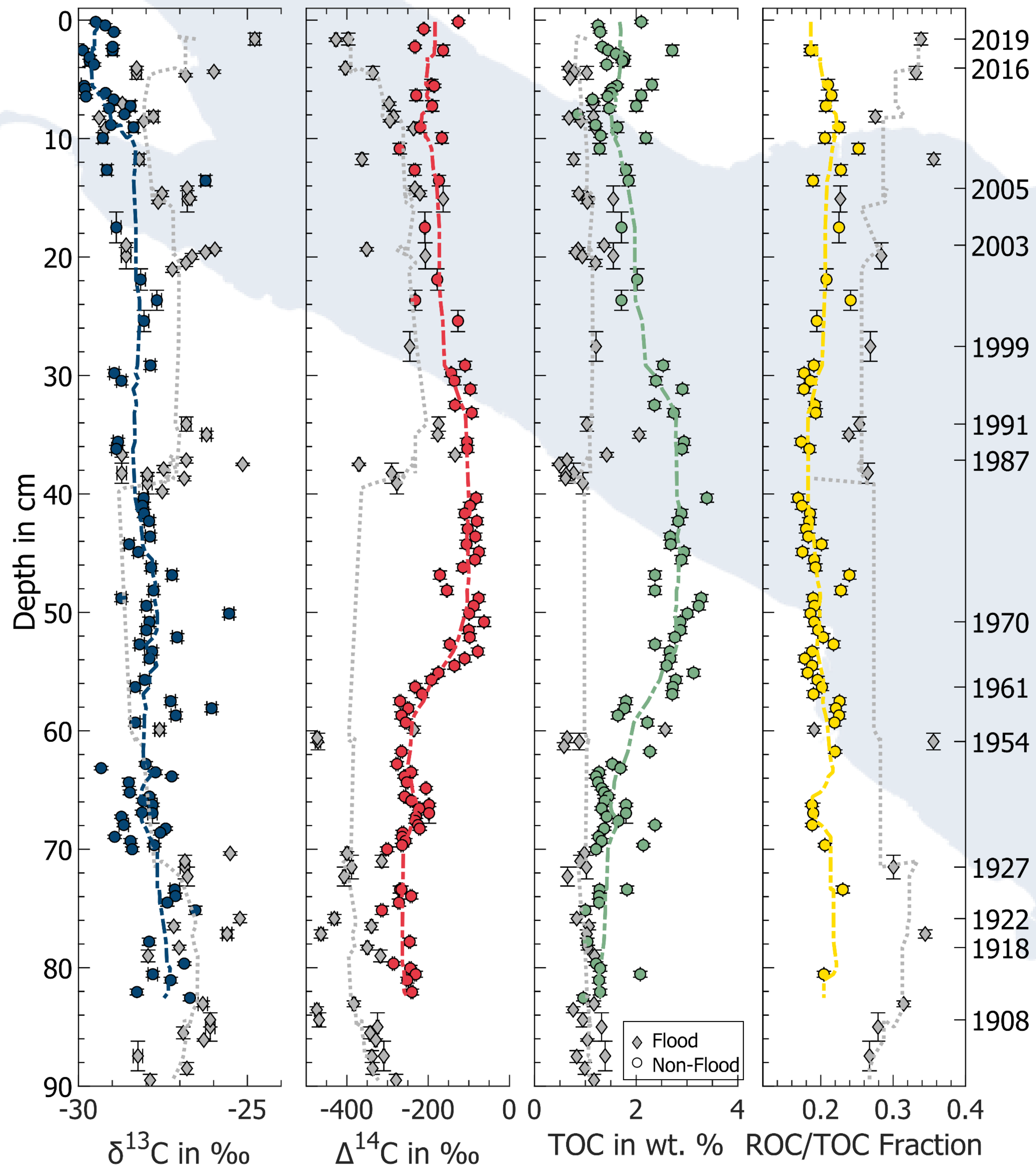
An MCMC-based approach using PyMC with the No-U-Turn Sampler (NUTS) was used to identify optimal OC pool contributions and turnover times (τ) to fit observed ^{14}C, ^{13}C, and C/N values. We used a hierarchical mixing model for OC pools with literature endmember values and ROC/TOC ratio as additional constraint for petrogenic OC.

Aquatic	Rock-derived	Soil-derived
^{13}C = -32.5 ± 0.5 ‰ [1]	^{13}C = -22.5 ± 0.5 ‰[1]	^{13}C = -27 ± 0.5 ‰[1]
C/N = 6.69 ± 0.1	C/N = 4.60 ± 0.1	C/N = 12.33 ± 0.1
DI^{14}C Pool: τ = 2-10 yrs[2], 15% ^{14}C free[3]		



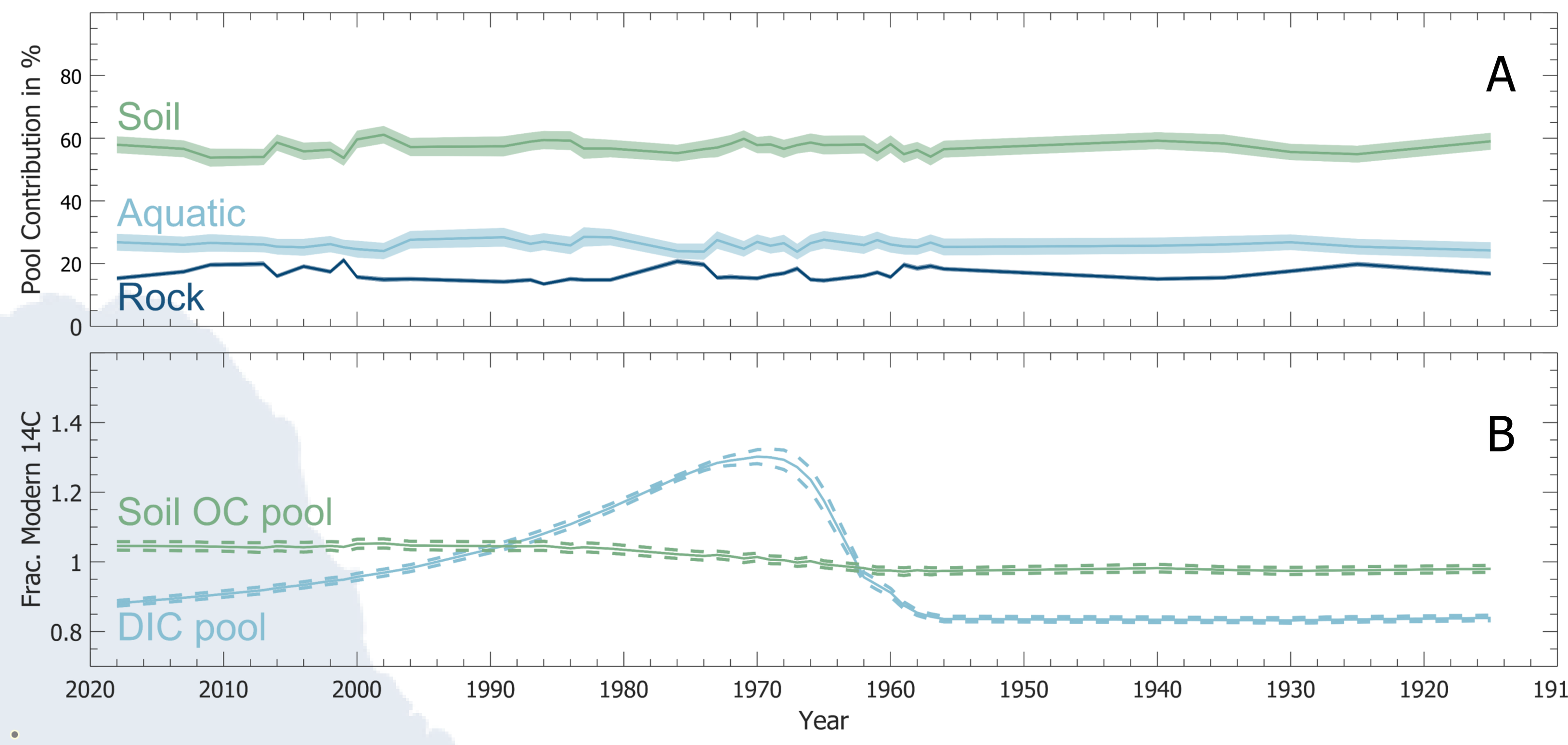
Finding 1: A muted bomb spike

Analysis of bulk organic ^{14}C content shows an increase of Δ^{14}C from ca. -300‰ to -100‰ in the early 1960s. We interpret this as the manifestation of the atmospheric radiocarbon bomb spike in the sediment. δ^{13}C signatures do not show a systematic shift during this period, pointing to a stable mixture of autochthonous and allochthonous OC.



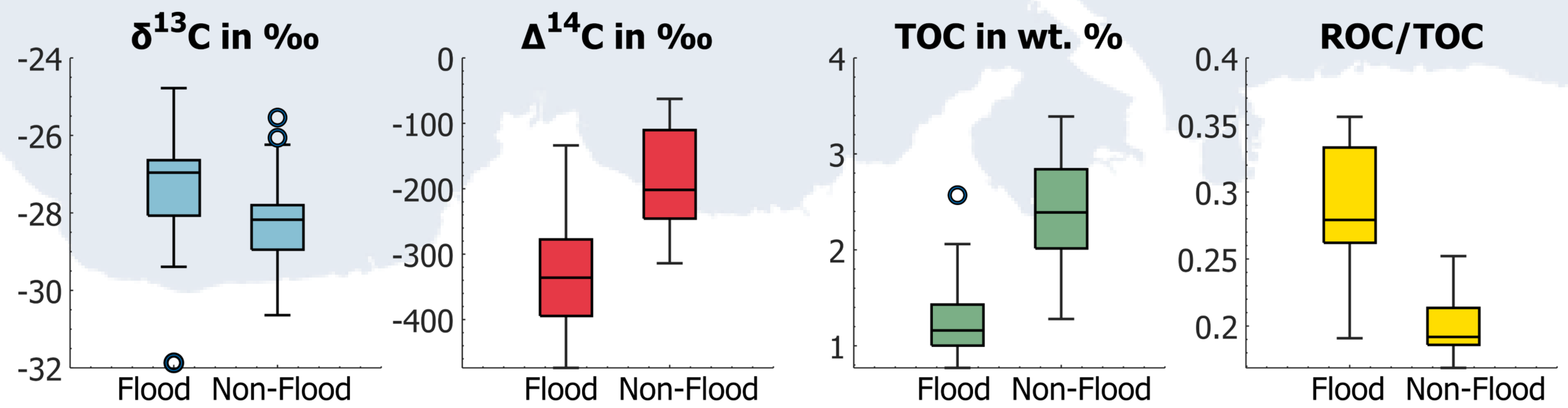
Finding 2: OC endmember transit times

Modelling the ^{14}C content of OC pools reveals that the aquatic DIC pool rapidly incorporates bomb carbon producing the signal observed in the sediment. Soil OC, however, reacts more slowly. The observed ^{14}C content corresponds to an apparent transit time of 161±19 years for this pool. This argues for a significant contribution of older, pre-aged, carbon and/or intermediate storage of OC.



Finding 3: More bedrock OC in floods

Flood layers are characterized by older ^{14}C signatures and higher δ^{13}C values, indicating a greater contribution of pre-aged OC. In combination with their higher content of ROC (OC that is not oxidized at 400°C) this also points to a higher contribution of rock-derived OC.



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References:

1: Blattmann et al. 2019 (Chem. Geol. 503) 2: Gilfedder et al. 2010 (GCCA 74(11)) 3: Blattmann et al. 2018 (Radiocarbon 60)

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