PP12B-05 - Constraints on the Deglacial Release of Geologic Carbon Using Atmospheric ^{14}C and CO_2 Records

While a reinvigoration of ocean circulation and CO_2 outgassing is the leading explanation for atmospheric CO_2 rise since the Last Glacial Maximum (LGM), there is also evidence of marine geologic carbon release over the last 20,000 years. Much of this evidence points to regions of the mid-depth Pacific Ocean, where multiple radiocarbon (^{14}C) records show anomalously low $^{14}C/C$ values, potentially caused by the addition of ^{14}C-free geologic carbon [1,2]. To better constrain this geologic carbon release hypothesis, we aim to place an upper bound limit on the amount of carbon that may have been added, in addition to the geochemical pathway of that carbon. To do so, we numerical invert a carbon cycle model based on observational atmospheric CO_2 and ^{14}C records. Given these observational constraints, we use data assimilation techniques and an optimization algorithm to calculate the rate of carbon addition and its alkalinity-to-carbon ratio ($R_{A/C}$) over the last 20,000 years. Using the modeled planetary radiocarbon budget calculated in Hain et al. [3], we find observations allow for only ~300 Pg of carbon to be added, as a majority of the deglacial atmospheric ^{14}C decline is already explained by magnetic field strength changes and ocean circulation changes [3]. However, when we adjust the initial state of the model by increasing ^{14}C by 75‰ to match the observational ^{14}C records, we find that observations allow for ~3500 Pg of carbon addition with an average $R_{A/C}$ of ~1.4.
These results allow for the possibility of a large release of ^{14}C-free geologic carbon, which could provide local and regional ^{14}C anomalies, as the records have in the Pacific [1,2]. As this geological carbon was added with a $R_{A/C}$ of ~1.4, these results also imply that ^{14}C evidence for significant geologic carbon release since the LGM may not be taken as contributing to deglacial CO_2 rise, unless there is evidence for significant local acidification and corrosion of seafloor sediments. If the geologic carbon cycle is indeed more dynamic than previously thought, we may also need to rethink the approach to estimate the land/ocean carbon repartitioning from the deglacial stable carbon isotope budget.

[1] Rafter et al. (2019), GRL 46(23), 13950–13960. [2] Ronge et al. (2016), Nature Communications 7(1), 11487. [3] Hain et al. (2014), EPSL 394, 198–208.

RYAN GREEN, MATHIS HAIN AND PATRICK
RAFTER

AGU Fall Meeting 2021

https://agu.confex.com/agu/fm21/meetingapp.cgi/Paper/989171