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A preliminary record of changes in Southern Hemisphere atmospheric OH abundance from 14CO in glacial ice (Law Dome, Antarctica, 1870 AD to present)

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Hydroxyl, OH, is the main tropospheric oxidant and determines the lifetime of methane and most other trace gases in the atmosphere, thereby controlling the amount of greenhouse warming produced by these gases. Changes in OH concentration ([OH]) in response to large changes in reactive trace gas emissions (which may occur in the future) are uncertain. Measurements of 14C-containing carbon monoxide (14CO) and other tracers such as methyl chloroform over the last ≈25 years have been successfully used to monitor changes in average [OH], but there are no observational constraints on [OH] further back in time. Reconstructions of 14CO from ice cores at sites with very high snow accumulation rates can provide such constraints, as rapid snow burial limits in-situ production of 14CO by cosmic rays directly in the ice. A joint US and Australian team sampled and measured firn air and ice at Law Dome, Antarctica (2018-19 season, site DE08-OH, 1.2 m a-1 ice-equivalent snow accumulation), to a maximum depth of 240 m. Trapped air was extracted from the ice using an on-site large-volume ice melting system. Preliminary comparisons of methane measured in the samples to existing ice core records and atmospheric measurements suggest ice core air sample ages spanning from the 1870s to the early 2000s. Firn-air samples from the snow surface to 81 m depth capture air from the early 2000s to present. Analyses of [CO] and halocarbons in the samples show a relatively low and stable procedural CO blank and demonstrate that the samples are unaffected by ambient air inclusion. 14CO analyses in these firn and ice core air samples have been successfully completed. Corrections for in-situ 14CO production, validated against direct atmospheric measurements for the more recent samples, have allowed us to develop a preliminary 14CO history. This history will be interpreted with the aid of the GEOS-Chem chemistry-transport model to place the first observational constraints on the variability of Southern Hemisphere [OH] since ≈1870 AD.

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