A Preliminary Record of Changes in Southern Hemisphere Atmospheric OH Abundance from ^{14}CO in Glacial Ice (Law Dome, Antarctica, 1870 AD to Present)

Peter D. Neff[1,2], Vasilii V. Petrenko[1], David Etheridge[3], Andrew M. Smith[4], Edward Crosier[1], Benjamin Hmiel[1], David Thornton[3], Lenneke Jong[5], Ross Beaudette[6], Christina Harth[6], Ray L. Langenfelds[3], Blagoj Mitrevski[3], Mark Curran[5], Christo Buizert[7], Lee Murray[1], Cathy M. Trudinger[3], Michael Dyonisius[1], Jessica Ng[6], Jeff Severinghaus[6], Ray F. Weiss[6]

[1]Department of Earth and Environmental Sciences, University of Rochester, Rochester, NY 14627, USA
[2]Department of Soil, Water, and Climate, University of Minnesota Twin Cities, Saint Paul, MN, 55108, USA
[3]Climate Science Centre, CSIRO Oceans and Atmosphere, Aspendale, Victoria 3195, Australia
[4]Australian Nuclear Science and Technology Organisation, Kirrawee DC, NSW 2232, Australia
[5]Australian Antarctic Division and Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania 7001, Australia
[6]Scripps Institution of Oceanography, La Jolla, CA, 92093, USA
[7]College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR, 97331, USA

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 ^{14}C-containing carbon monoxide (^{14}CO) 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 ^{14}CO from ice cores at sites with very high snow accumulation rates can provide such constraints, as rapid snow burial limits in-situ production of ^{14}CO 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. ^{14}CO analyses in these firn and ice core air samples have been successfully completed. Corrections for in-situ ^{14}CO production, validated against direct atmospheric measurements for the more recent samples, have allowed us to develop a preliminary ^{14}CO 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.