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Records of Northern Hemisphere atmospheric carbon monoxide and hydrogen back to about 1960 AD from Greenland firn air

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Carbon monoxide (CO) plays a key role in global atmospheric chemistry by being the main sink of atmospheric hydroxyl radicals (OH). The relatively short CO atmospheric lifetime (about 2 months) together with larger emissions in the Northern Hemisphere (NH) currently result in a large interhemispheric [CO] gradient (1). Reliable records of past [CO] from both hemispheres are therefore essential for understanding past changes in atmospheric [OH] as well as changes in biomass burning. Earlier attempts at reconstruction of NH [CO] suffered from apparent in-situ CO production in ice and firn (2, 3). We present a record of high-latitude NH [CO] to about 1960 AD, from measurements by four different laboratories of firn air collected at the NEEM ice core site in Greenland. Procedural blanks indicate no detectable [CO] contamination from sampling. The smooth, gradual changes in the [CO] profile with depth in the firn, as well as excellent agreement with a firn air record from another cold Greenland site (NGRIP) are consistent with the NEEM firn CO record being unaltered. Our results suggest that high-latitude NH mean annual [CO] increased from about 1960 to the 1980s, with measured peak values of 155 – 160 ppb. Firn air data from sites in Antarctica show Southern Hemisphere [CO] also increasing during this time period. Our results further suggest that high-latitude NH mean annual [CO] gradually declined after the 1980s, which is consistent with early direct atmospheric measurements. [CO] in the oldest samples is 135 – 140 ppb. In addition, we present the NEEM firn record of molecular hydrogen (H_2), from measurements by three laboratories. The main features of the [H_2] record closely parallel the [CO] record, with results suggesting an increase in [H_2] from about 1960 to the 1980s, followed by a gradual decline. This is again consistent with early direct atmospheric measurements. The similarity in the main features of [CO] and [H_2] records is expected because of broadly similar sources for the two gases, and is once again consistent with the NEEM firn [CO] record being unaltered. Dates given are preliminary and approximate only. Modeling is currently in progress to use the NEEM firn [CO] and [H_2] records to constrain the high-latitude NH atmospheric history for these gases.

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