Abstract ID : **217**

History of atmospheric carbon monoxide over Greenland and Antarctica since preindustrial times

Content

The level of carbon monoxide (CO) in our atmosphere influences its oxidising capacity because CO reacts readily with hydroxyl radical (OH) and ozone. Obtaining reliable records of CO mixing ratios from ice cores is important to constrain the impact of CO on past atmospheric chemistry, evaluate climate-chemistry models, and to reconstruct past variability in CO sources.

We present results from two studies: a multi-site investigation of Greenland ice core CO and a new investigation of Antarctic ice core CO coupled with firn air reconstructions. In both cases, an optical-feedback cavity-enhanced absorption spectrometer (OF-CEAS) was coupled with a continuous melter system to obtain precise, high resolution CO measurements from the ancient air bubbles trapped in ice cores. By analysing several ice cores with different site conditions (e.g., temperature, accumulation rate, chemical loading) we were able to produce reliable atmospheric reconstructions for both poles. For Greenland in particular, using multiple ice cores is critical because high frequency (less than decadal scale) non-atmospheric variability in CO mixing ratio is resolved in all the cores, which likely results from production within the ice prior to analysis.

Our Greenland reconstruction spans 1700 to 1957 CE and overlaps with a published multi-site Greenland firn air CO history. From 1700 to 1875 CE, the record reveals quasi-stable CO mixing ratios in the 100–115 ppbv range. From 1875 to 1957 CE, CO increases gradually from 114 ± 4 to 147 ± 6 ppbv. Our Antarctic ice core-based reconstruction spans -835 CE to 1897 CE. An atmospheric reconstruction based on firn air data from five Antarctic locations extend this record forward to overlap with atmospheric monitoring at Mawson Station. Temporal trends in our CO record broadly agree with existing Antarctic datasets but mixing ratios are significantly lower (<40 ppbv). No peak in CO mixing ratio in the late 1800s is resolved, with implications for Southern Hemisphere biomass burning history.

Both records provide vital constraints for future modelling studies of atmospheric chemistry since the preindustrial period.

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Track Classification: Biogeochemical Cycles in the Earth system – data and models