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Bridging the gap between the ice core and instrumental gas record: new high resolution CH4 and CO records from West Antarctica

Content

The mixing ratio of atmospheric methane (CH_4) has almost tripled since 1800 CE, with most of the increase having occurred within the last 100 years. Accurate, highly resolved data over this period are critical to understand and model future climate change. Yet, much of our knowledge of Antarctic CH_4 evolution since western industrialisation (~1800 CE) comes from a single ice core record (Law Dome) with associated firn-air studies required to bridge the gap between ice core and observed trace gas measurements, which began at 1983 CE.

To further close the data gap, we present two high resolution records of atmospheric CH_4 from high-accumulation sites in West Antarctica: Jurassic (acc. ~60 cm w.eq./yr) and Bryan Coast (acc. ~50 cm w.eq./yr). Our continuous measurements utilise high-sensitivity, cavity based, laser spectroscopy (OF-CEAS) and gas ages are predicted to span from 1910 to 1989 and 1810 to 1975 CE in the two cores respectively. However, dating is complicated by an exponential increase in accumulation rate over the region since the turn of the 20th century. Our results add data-density to a critical period in recent atmospheric history and allow re-examination of multidecadal scale growth rates in the context of Law Dome and instrumental observations. Methane increases by 920 ppb between 1810-1989 CE with the greatest growth rates in the 1970s and marked slowdowns in both the 1940s and into the 1980s.

We also present associated continuous baseline Antarctic carbon monoxide (CO) records. Consistency between the 65-year overlapping sections of each core suggest a common atmospheric signal is preserved. Data range from 35 to 66 ppb (pending minor corrections), increasing towards present. However, persistent quasi-annual periodicity (up to 15 ppb in amplitude) throughout both records suggest other processes are also involved. Firn-based smoothing precludes an atmospheric origin while similar signals, thought to result from in-situ CO production in Northern Hemisphere records, have yet to be observed in Antarctic ice. Here, correlation with hydrogen peroxide suggests a seasonal component.

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