Constructing an annually resolved time series of atmospheric $\Delta^{14}C$-CO_2 for Barrow, Alaska

Datasets used

1. The IntCal13 dataset provides pre-bomb radiocarbon values at 5-year resolution until 1950 (Reimer et al., 2013).
2. Radiocarbon measurements made in Fruholmen, Norway cover the period from December 1962 through June 1993 (Nydal and Lövseth, 1996). Limited measurements from Point Barrow between 1985 and 1991 confirm that this dataset provides a close approximation for Barrow, Alaska values (Meijer et al., 2008).
3. Radiocarbon measurements made in Point Barrow between June 1999 through December 2007 were published in Graven *et al*., (Graven et al., 2012).
4. On August 12, 2012, July 13, 2013, September 2, 2014 and September 7, 2014, we collected air samples from the Barrow Environmental Observatory in 3 L evacuated stainless steel canisters. CO_2 was extracted from air samples and analyzed for radiocarbon according to the methods described in the main text.

Data selection and gap filling

Due to large-scale circulation patterns and ecosystem carbon exchange, atmospheric radiocarbon values vary seasonally by ~10‰ in Barrow, peaking in late winter (Graven et al., 2012). Because CO_2 fixation occurs primarily in summer, summertime radiocarbon values best represent atmospheric inputs for turnover time modeling. For each year with available radiocarbon data, we calculated an annual summertime average using measurements from July and August, the months of maximum CO_2 uptake in Barrow (Dennis et al., 1978; Zona et al., 2014). Because July/August data were unavailable for 2014, we used the average of the measurements made on September 2 and 7. From the IntCal13 dataset, annually resolved data were interpolated using a smoothing spline with 1 degree of freedom (R version 3.3.3 “Another Canoe,” 2017-03-06).

With these annualized datasets, no data were available for the following years: 1951-1962, 1992-2000, and 2008-2011. For each of the latter two gaps, we predicted missing data from an exponential model using up to 10 years of annualized data preceding or following the gap. The first model (R^2 = 0.9976) included data from 1983-2010, and the second model (R^2 = 0.9658) covered the years 1999-2014. The gap between 1951 and 1962 spanned the period of rapid atmospheric radiocarbon increase from nuclear weapons testing. For this period, we used a constant $\Delta^{14}C$ value of -24.5 ‰ from 1951 through 1957, followed by a linear increase from 1958 through 1962.

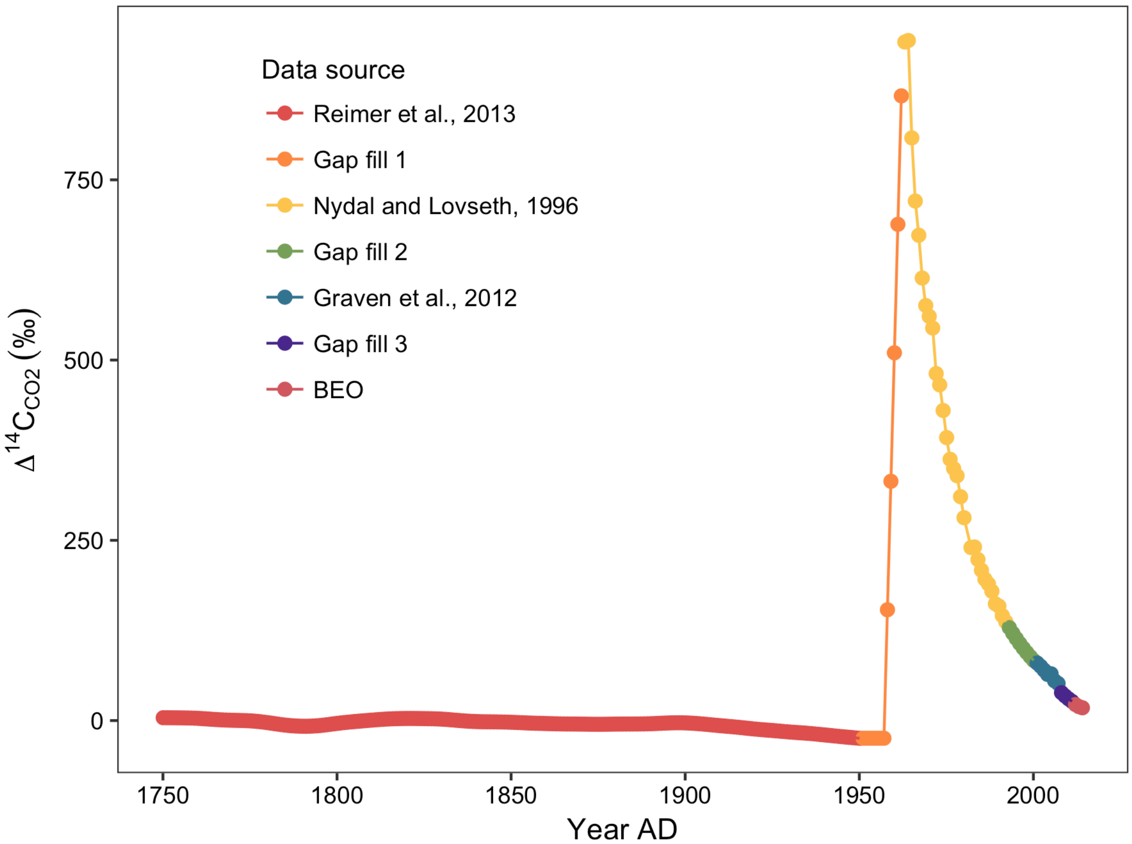

Figure S1. Compiled time series of atmospheric $\Delta^{14}C$ in Barrow, Alaska. Points represent summertime averages based on recent measurements (BEO), published values, and interpolated estimates.

Table S1

Compiled time series of atmospheric Δ $^{14}C-CO_2$ in Barrow, Alaska

Data source	Year	$\Delta^{14}C-CO_2$ (‰)
Reimer *et al.*, 2013	1750	4.0
Reimer *et al.*, 2013	1751	3.9
Reimer *et al.*, 2013	1752	3.9
Reimer *et al.*, 2013	1753	3.9
Reimer *et al.*, 2013	1754	3.8
Reimer *et al.*, 2013	1755	3.8
Reimer *et al.*, 2013	1756	3.7
Reimer *et al.*, 2013	1757	3.6
Reimer *et al.*, 2013	1758	3.5
Reimer *et al.*, 2013	1759	3.3
Reimer *et al.*, 2013	1760	3.1
Reimer *et al.*, 2013	1761	2.8
Reimer *et al.*, 2013	1762	2.5
Reimer *et al.*, 2013	1763	2.1
Reimer *et al.*, 2013	1764	1.8
Reimer *et al.*, 2013	1765	1.5
Reimer *et al.*, 2013	1766	1.2
Reimer *et al.*, 2013	1767	0.9
Reimer *et al.*, 2013	1768	0.7
Reimer *et al.*, 2013	1769	0.5
Reimer *et al.*, 2013	1770	0.4
Reimer *et al.*, 2013	1771	0.3
Reimer *et al.*, 2013	1772	0.2
Reimer *et al.*, 2013	1773	0.0
Reimer *et al.*, 2013	1774	-0.2
Reimer *et al.*, 2013	1775	-0.4
Reimer *et al.*, 2013	1776	-0.7
Reimer *et al.*, 2013	1777	-1.2
Reimer *et al.*, 2013	1778	-1.7
Reimer *et al.*, 2013	1779	-2.3
Reimer *et al.*, 2013	1780	-2.9
Reimer *et al.*, 2013	1781	-3.6
Reimer *et al.*, 2013	1782	-4.3
Reimer *et al.*, 2013	1783	-5.0
Reimer *et al.*, 2013	1784	-5.7
Reimer *et al.*, 2013	1785	-6.3
Reimer *et al.*, 2013	1786	-6.8
Reimer *et al.*, 2013	1787	-7.2
Reimer *et al.*, 2013	1788	-7.5

(table continues)

Data source	Year	$\Delta^{14}C-CO_2$ (‰)
Reimer *et al.*, 2013	1789	-7.8
Reimer *et al.*, 2013	1790	-7.9
Reimer *et al.*, 2013	1791	-7.9
Reimer *et al.*, 2013	1792	-7.8
Reimer *et al.*, 2013	1793	-7.6
Reimer *et al.*, 2013	1794	-7.3
Reimer *et al.*, 2013	1795	-6.9
Reimer *et al.*, 2013	1796	-6.4
Reimer *et al.*, 2013	1797	-5.8
Reimer *et al.*, 2013	1798	-5.1
Reimer *et al.*, 2013	1799	-4.5
Reimer *et al.*, 2013	1800	-3.9
Reimer *et al.*, 2013	1801	-3.3
Reimer *et al.*, 2013	1802	-2.8
Reimer *et al.*, 2013	1803	-2.3
Reimer *et al.*, 2013	1804	-1.8
Reimer *et al.*, 2013	1805	-1.4
Reimer *et al.*, 2013	1806	-1.0
Reimer *et al.*, 2013	1807	-0.5
Reimer *et al.*, 2013	1808	-0.1
Reimer *et al.*, 2013	1809	0.3
Reimer *et al.*, 2013	1810	0.7
Reimer *et al.*, 2013	1811	1.0
Reimer *et al.*, 2013	1812	1.4
Reimer *et al.*, 2013	1813	1.7
Reimer *et al.*, 2013	1814	2.0
Reimer *et al.*, 2013	1815	2.3
Reimer *et al.*, 2013	1816	2.5
Reimer *et al.*, 2013	1817	2.7
Reimer *et al.*, 2013	1818	2.8
Reimer *et al.*, 2013	1819	2.9
Reimer *et al.*, 2013	1820	2.9
Reimer *et al.*, 2013	1821	2.9
Reimer *et al.*, 2013	1822	2.9
Reimer *et al.*, 2013	1823	2.9
Reimer *et al.*, 2013	1824	2.8
Reimer *et al.*, 2013	1825	2.7
Reimer *et al.*, 2013	1826	2.6
Reimer *et al.*, 2013	1827	2.5
Reimer *et al.*, 2013	1828	2.4
Reimer *et al.*, 2013	1829	2.2
Reimer *et al.*, 2013	1830	2.0
Reimer *et al.*, 2013	1831	1.7

(table continues)

Data source	Year	$\Delta^{14}C$-CO_2 (‰)
Reimer *et al.*, 2013	1832	1.3
Reimer *et al.*, 2013	1833	0.9
Reimer *et al.*, 2013	1834	0.5
Reimer *et al.*, 2013	1835	0.1
Reimer *et al.*, 2013	1836	-0.3
Reimer *et al.*, 2013	1837	-0.7
Reimer *et al.*, 2013	1838	-1.0
Reimer *et al.*, 2013	1839	-1.2
Reimer *et al.*, 2013	1840	-1.4
Reimer *et al.*, 2013	1841	-1.6
Reimer *et al.*, 2013	1842	-1.6
Reimer *et al.*, 2013	1843	-1.7
Reimer *et al.*, 2013	1844	-1.7
Reimer *et al.*, 2013	1845	-1.8
Reimer *et al.*, 2013	1846	-1.9
Reimer *et al.*, 2013	1847	-1.9
Reimer *et al.*, 2013	1848	-2.1
Reimer *et al.*, 2013	1849	-2.2
Reimer *et al.*, 2013	1850	-2.4
Reimer *et al.*, 2013	1851	-2.5
Reimer *et al.*, 2013	1852	-2.8
Reimer *et al.*, 2013	1853	-3.0
Reimer *et al.*, 2013	1854	-3.2
Reimer *et al.*, 2013	1855	-3.4
Reimer *et al.*, 2013	1856	-3.6
Reimer *et al.*, 2013	1857	-3.7
Reimer *et al.*, 2013	1858	-3.9
Reimer *et al.*, 2013	1859	-4.0
Reimer *et al.*, 2013	1860	-4.1
Reimer *et al.*, 2013	1861	-4.3
Reimer *et al.*, 2013	1862	-4.4
Reimer *et al.*, 2013	1863	-4.5
Reimer *et al.*, 2013	1864	-4.6
Reimer *et al.*, 2013	1865	-4.7
Reimer *et al.*, 2013	1866	-4.8
Reimer *et al.*, 2013	1867	-4.8
Reimer *et al.*, 2013	1868	-4.8
Reimer *et al.*, 2013	1869	-4.9
Reimer *et al.*, 2013	1870	-4.9
Reimer *et al.*, 2013	1871	-5.0
Reimer *et al.*, 2013	1872	-5.1
Reimer *et al.*, 2013	1873	-5.1
Reimer *et al.*, 2013	1874	-5.2

(table continues)

Data source	Year	$\Delta^{14}C-CO_2$ (‰)
Reimer *et al.*, 2013	1875	-5.2
Reimer *et al.*, 2013	1876	-5.2
Reimer *et al.*, 2013	1877	-5.1
Reimer *et al.*, 2013	1878	-5.0
Reimer *et al.*, 2013	1879	-5.0
Reimer *et al.*, 2013	1880	-4.9
Reimer *et al.*, 2013	1881	-4.9
Reimer *et al.*, 2013	1882	-4.8
Reimer *et al.*, 2013	1883	-4.8
Reimer *et al.*, 2013	1884	-4.8
Reimer *et al.*, 2013	1885	-4.8
Reimer *et al.*, 2013	1886	-4.8
Reimer *et al.*, 2013	1887	-4.7
Reimer *et al.*, 2013	1888	-4.6
Reimer *et al.*, 2013	1889	-4.5
Reimer *et al.*, 2013	1890	-4.4
Reimer *et al.*, 2013	1891	-4.2
Reimer *et al.*, 2013	1892	-4.0
Reimer *et al.*, 2013	1893	-3.7
Reimer *et al.*, 2013	1894	-3.5
Reimer *et al.*, 2013	1895	-3.3
Reimer *et al.*, 2013	1896	-3.2
Reimer *et al.*, 2013	1897	-3.1
Reimer *et al.*, 2013	1898	-3.1
Reimer *et al.*, 2013	1899	-3.1
Reimer *et al.*, 2013	1900	-3.2
Reimer *et al.*, 2013	1901	-3.4
Reimer *et al.*, 2013	1902	-3.7
Reimer *et al.*, 2013	1903	-4.0
Reimer *et al.*, 2013	1904	-4.4
Reimer *et al.*, 2013	1905	-4.8
Reimer *et al.*, 2013	1906	-5.3
Reimer *et al.*, 2013	1907	-5.7
Reimer *et al.*, 2013	1908	-6.2
Reimer *et al.*, 2013	1909	-6.6
Reimer *et al.*, 2013	1910	-7.1
Reimer *et al.*, 2013	1911	-7.5
Reimer *et al.*, 2013	1912	-7.9
Reimer *et al.*, 2013	1913	-8.4
Reimer *et al.*, 2013	1914	-8.8
Reimer *et al.*, 2013	1915	-9.3
Reimer *et al.*, 2013	1916	-9.8
Reimer *et al.*, 2013	1917	-10.3

(table continues)

Data source	Year	$\Delta^{14}C-CO_2$ (‰)
Reimer *et al.*, 2013	1918	-10.8
Reimer *et al.*, 2013	1919	-11.3
Reimer *et al.*, 2013	1920	-11.8
Reimer *et al.*, 2013	1921	-12.2
Reimer *et al.*, 2013	1922	-12.6
Reimer *et al.*, 2013	1923	-13.0
Reimer *et al.*, 2013	1924	-13.4
Reimer *et al.*, 2013	1925	-13.8
Reimer *et al.*, 2013	1926	-14.2
Reimer *et al.*, 2013	1927	-14.6
Reimer *et al.*, 2013	1928	-15.1
Reimer *et al.*, 2013	1929	-15.5
Reimer *et al.*, 2013	1930	-15.9
Reimer *et al.*, 2013	1931	-16.2
Reimer *et al.*, 2013	1932	-16.6
Reimer *et al.*, 2013	1933	-16.9
Reimer *et al.*, 2013	1934	-17.3
Reimer *et al.*, 2013	1935	-17.6
Reimer *et al.*, 2013	1936	-18.0
Reimer *et al.*, 2013	1937	-18.5
Reimer *et al.*, 2013	1938	-19.0
Reimer *et al.*, 2013	1939	-19.4
Reimer *et al.*, 2013	1940	-19.9
Reimer *et al.*, 2013	1941	-20.4
Reimer *et al.*, 2013	1942	-20.9
Reimer *et al.*, 2013	1943	-21.4
Reimer *et al.*, 2013	1944	-21.9
Reimer *et al.*, 2013	1945	-22.4
Reimer *et al.*, 2013	1946	-22.8
Reimer *et al.*, 2013	1947	-23.3
Reimer *et al.*, 2013	1948	-23.7
Reimer *et al.*, 2013	1949	-24.1
Reimer *et al.*, 2013	1950	-24.6
Gap fill 1	1951	-24.5
Gap fill 1	1952	-24.5
Gap fill 1	1953	-24.5
Gap fill 1	1954	-24.5
Gap fill 1	1955	-24.5
Gap fill 1	1956	-24.5
Gap fill 1	1957	-24.5
Gap fill 1	1958	153.7
Gap fill 1	1959	331.9
Gap fill 1	1960	510.1

(table continues)

Data source	Year	$\Delta^{14}C-CO_2$ (‰)
Gap fill 1	1961	688.3
Gap fill 1	1962	866.5
Nydal & Lövseth, 1996	1963	941.2
Nydal & Lövseth, 1996	1964	943.3
Nydal & Lövseth, 1996	1965	808.2
Nydal & Lövseth, 1996	1966	720.6
Nydal & Lövseth, 1996	1967	673.2
Nydal & Lövseth, 1996	1968	613.8
Nydal & Lövseth, 1996	1969	575.7
Nydal & Lövseth, 1996	1970	560.6
Nydal & Lövseth, 1996	1971	544.5
Nydal & Lövseth, 1996	1972	481.3
Nydal & Lövseth, 1996	1973	465.7
Nydal & Lövseth, 1996	1974	430.1
Nydal & Lövseth, 1996	1975	392.5
Nydal & Lövseth, 1996	1976	362.4
Nydal & Lövseth, 1996	1977	349.7
Nydal & Lövseth, 1996	1978	339.6
Nydal & Lövseth, 1996	1979	310.5
Nydal & Lövseth, 1996	1980	281.4
Nydal & Lövseth, 1996	1982	240.0
Nydal & Lövseth, 1996	1983	240.8
Nydal & Lövseth, 1996	1984	223.4
Nydal & Lövseth, 1996	1985	208.5
Nydal & Lövseth, 1996	1986	196.1
Nydal & Lövseth, 1996	1987	189.5
Nydal & Lövseth, 1996	1988	179.4
Nydal & Lövseth, 1996	1989	162.0
Nydal & Lövseth, 1996	1990	158.8
Nydal & Lövseth, 1996	1991	145.6
Nydal & Lövseth, 1996	1992	137.0
Gap fill 2	1993	128.9
Gap fill 2	1994	121.1
Gap fill 2	1995	113.8
Gap fill 2	1996	106.9
Gap fill 2	1997	100.5
Gap fill 2	1998	94.4
Gap fill 2	1999	88.7
Gap fill 2	2000	83.4
Graven *et al*., 2012	2001	79.8
Graven *et al*., 2012	2002	75.3
Graven *et al*., 2012	2003	70.0
Graven *et al*., 2012	2004	64.0

(table continues)

Data source	Year	$\Delta^{14}C$-CO_2 (‰)
Graven *et al*., 2012	2005	64.9
Graven *et al*., 2012	2006	55.2
Graven *et al*., 2012	2007	51.5
Gap fill 3	2008	38.7
Gap fill 3	2009	34.2
Gap fill 3	2010	30.2
Gap fill 3	2011	26.6
Barrow Environmental Observatory	2012	22.2
Barrow Environmental Observatory	2013	19.3
Barrow Environmental Observatory	2014	17.8

Note: $\Delta^{14}C$-CO_2 values represent mean summertime atmospheric radiocarbon in Barrow, Alaska, based on recent measurements (Barrow Environmental Observatory), published values, and interpolated estimates.

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