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Fifteen years of atmospheric methane and carbon dioxide mixing ratio measurements at the mountain site Kasprowy Wierch, southern Poland

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The Kasprowy Wierch station is located in the south of Poland, within the High Tatra Mountains. The meteorological observatory which hosts the monitoring station is located on top of a mountain peak called Kasprowy Wierch (49^o14'N, 19^o59'E, 1989 m a.s.l., 300 m above the tree line). Climate of Kasprowy Wierch area is typical for a continental mountain location, with relatively large diurnal and seasonal variations of temperature, high precipitation rate, frequent changes of atmospheric pressure and strong winds.

Regular observations of atmospheric CH_4 and CO_2mixing ratios at Kasprowy Wierch begun in 1994. Continuous measurements using GC technique were initiated in 1996. The available dataset of CO_2 and CH_4mixing ratios at Kasprowy Wierch comprise a valuable source of information about temporal variability of those gases in the atmosphere above central Europe over 15-year period.

Significant year-to-year variability of carbon dioxide mixing ratio, both with respect to the observed annual growth rate as well as the amplitude of seasonal changes, was observed. The presented carbon dioxide mixing ratio record reveals typical behaviour of atmospheric CO_2 observed at mid-latitude continental sites of the Northern Hemisphere. The winter maximum ends in spring, when the photosynthetic sink starts to operate. From that time on, the CO_2 mixing ratio gradually decreases, reaching a minimum in August/September. Afterwards, the CO_2 level increases, reaching winter maximum in February/March. The length of the CO_2 deficit season at Kasprowy Wierch, defined as the period when CO_2 mixing ratio remains below the long-term trend curve, is getting shorter (c.a. -0.5 ppm year^{-1}, averaged over the observation period 1994-2008). The average peak-to-peak amplitude for the period 1994-2008 is equal c.a. 19 ppm (minimum value of 14,7 ppm recorded in 2003 and maximum of 20,7 ppm recorded in 1995). It is worth to note that the 2003 summer draw-down of CO_2 concentration at Kasprowy Wierch was anomalously low (peak-to-peak amplitude of 14.7 ppm, when compared to 20.1 ppm in 2002 and 18.1 ppm in 2004). This effect was most probably linked to extreme heat wave in summer 2003 which affected mostly western Europe and reduced photosynthetic activity on large areas of the European continent. The mean annual growth-rate of CO_2 mixing ratio at Kasprowy Wierch, averaged over the observation period (1994-2008), is equal approximately 2 ppm year^{-1}. This value is comparable to other "clean" stations located in European continent.

No significant seasonal cycle of methane has been detected at Kasprowy Wierch. Apparently, the weak seasonal signal, connected with seasonality of UV radiation and concentration of OH radicals, is overshadowed by relatively strong, mainly anthropogenic emissions of CH_4, related to ruminants, leakages from natural gas supply, coal mining and waste deposits, which are not likely to vary significantly with season. The annual growth-rate of methane mixing ratio at Kasprowy Wierch, averaged over the observation period (1994-2008), is equal c.a. 2 ppb year^{-1}. The mean level of CH_4 mixing ratio recorded in 2007 (1843.5 ppb) is comparable with other European stations.