Thirty Years of Atmospheric CH_4 Monitoring: What Have We Learned?

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Methane (CH_4) is the most important greenhouse gas influenced by human activities after CO_2, with 0.5 W m^{-2} radiative forcing since 1750. Its atmospheric chemistry results in additional indirect climate effects from production of tropospheric O_3, which also affects air quality, and stratospheric H_2O abundance.

ESRL Global Monitoring Divivion has measured atmospheric CH_4 from discrete samples collected by the carbon cycle group's Global Cooperative Air Sampling Network since 1982. The trends, seasonal cycles, and spatial distributions obtained from these measurements provide large scale constraints on the global CH_4 budget including the atmospheric burden, total global emissions, and the imbalance between emissions and losses. Nearly every chemical transport model study of the global CH_4 budget uses these NOAA CH_4 observations to constrain estimated emissions. It is fitting that on the 40th Anniversary of the Global Monitoring Annual Conference we look back at some of the important discoveries that are based on these measurements, and then look at current trends in CH_4.

From the beginning of the measurements through 2006, the rate of increase was decreasing from ~14 ppb yr^{-1} in 1984 to near zero from 1999 to 2006. Superimposed on this decreasing growth rate are significant anomalies in global growth rate. These anomalies result from variations in natural wetland and biomass burning emissions and from changes in [OH], and they allow us to test our understanding of processes that emit CH_4. During 2007, atmospheric CH_4 began increasing again, and this increase continues through 2011 (see Figure). While greater than average temperatures in the Arctic were a likely contributor to the increase in 2007, since then, continued wet conditions in the tropics, particularly in the southern hemisphere, driven by strong La Niña conditions in 4 of the past 5 years, are the likely drivers. It is clear from our data that since 2007, emissions from the Arctic are not playing a significant role in the continued CH_4 increase.

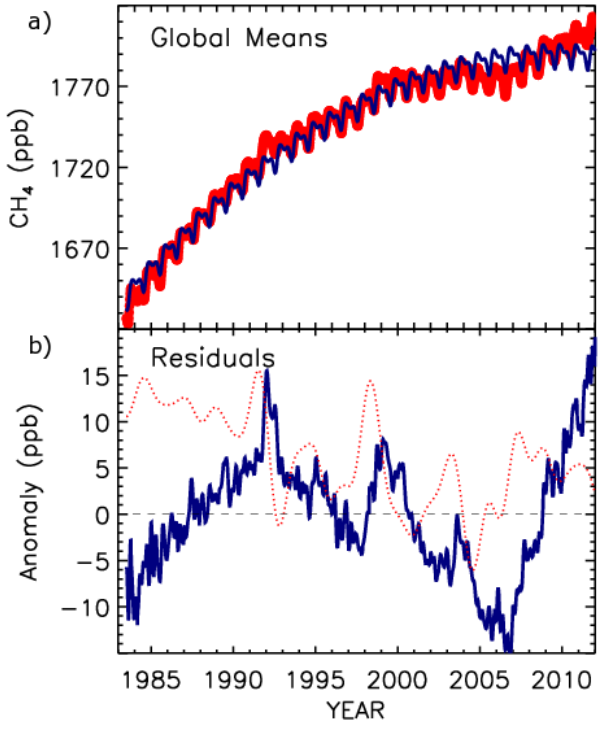

Figure 1. a) Globally averaged CH_4 dry air mole fractions (red). Blue line shows a function fitted to the global averages that approximates the long term trend and average seasonal cycle. b) Rate of increase in atmospheric CH_4 (red in ppb yr^{-1}) and residuals from function (blue).