Influences on the Growth Rate of Atmospheric Methane

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Direct and indirect components to anthropogenic radiative forcing by atmospheric CH_4 are estimated to be 0.7 W m^{-2}, or about one-half the contribution of CO_2. This large contribution of CH_4 to climate and global change makes it important that we try to quantify its rates of emissions to, and removal from, the atmosphere and how the global CH_4 burden will change in the future.

Measurements of atmospheric methane at Earth's surface from the CCGG group's cooperative air sampling network provide important information about the global CH_4 budget. During the past 2 decades, the global growth rate of CH_4 has slowed. Superimposed on this long-term decrease are significant anomalies in growth rate; these variations are highlighted in Figure 1 where residuals are plotted from a curve approximating the long-term global trend (2nd-order polynomial) and seasonal cycle (4 harmonics).

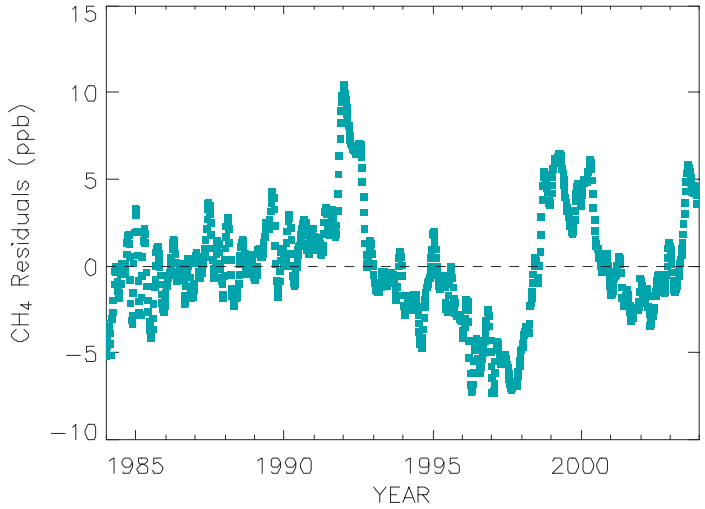

Figure 1. Residuals of a curve fitted to globally averaged CH_4 mole fractions.

Notable deviations from the long-term average trend and seasonal cycle occurred during 1991, 1992, and 1998. Changes to global CH_4 emissions and sinks caused by the eruption of Mt. Pinatubo, economic drivers, and climate variability have been proposed to explain these variations. For example, a distinct positive signal clearly emerged from the noise in 1991, and it was nearly perfectly timed with the eruption of Mt. Pinatubo. The mechanism for increased CH_4 growth rate was likely a reduction in OH production that resulted in lower CH_4 loss rates in the tropics. Other signals (1998) were the result of wide-scale changes in temperature and precipitation that affected CH_4 emissions from natural wetlands and biomass burning. These changes produced effects that persisted for only a year or two. Collapse of the Soviet economy resulted in decreased fossil fuel production, which resulted in lower CH_4 emissions starting in 1992. This change has been more persistent; we observed a coincident decrease in the difference between CH_4 measurements at polar Northern and Southern latitudes that is in good agreement with estimates of emissions reductions calculated for emissions inventories. Finally, some features are not yet explained. Globally averaged CH_4 was nearly constant from 1999-2002 but has increased again during 2003. These perturbations to the global methane budget have enhanced our understanding of particular processes, but we still can not use the measurements to predict the future atmospheric CH_4 burden.